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ABSTRACT

This booklet is the third in a series of four instructional aids designed to implement the first phase of the industriology concept. In this book, 46 information sheets and 26 job sheets cover the content and activities as suggested in the Teaching Plan (VT 010 313) for Development and Structure of Industry--the first phase of the Industriology concept. Each sheet is one or two pages in length and contains diagrams if necessary for clarity. Other documents in this series are available as VT 010 313-VT 010 315. (GR)

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INFORMATION
AND
JOB SHEETS

INDUSTRIOLOGY

DEVELOPMENT AND STRUCTURE OF INDUSTRY

VT010290

WISCONSIN STATE UNIVERSITY- PLATTEVILLE

ED037554

DEVELOPMENT AND STRUCTURE
OF
INDUSTRY

INFORMATION
AND
JOB SHEETS

INDUSTRIOLOGY PROJECT

Subject To Further
Research and Revision

SCHOOL OF INDUSTRY
WISCONSIN STATE UNIVERSITY-PLATTEVILLE

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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INTRODUCTION

This booklet contains the Information and Job Sheets necessary to adequately cover the content and activities as suggested in the Teaching Plan for Development and Structure of Industry - the first phase of the INDUSTRIOLOGY concept.

To effectively use the contents of this book, the instructor is encouraged to graphically reproduce the contents in any form he wishes to make it available for student use. It should be recognized that the material in this book is in the initial stages of development and evaluation. As more industrial arts instructors utilize the materials provided through INDUSTRIOLOGY, suggestions for improvement will be taken into consideration as the content is constantly evaluated and subsequently revised.

The titles of the Information and Job Sheets are listed in the first portion of this book as a ready reference index to the contents.

TITLES OF INSTRUCTION SHEETS

The following is a ready reference index to titles of instruction sheets provided for teaching Development and Structure of Industry - the first phase of INDUSTRIOLOGY. The titles of the instruction sheets are grouped by Information Sheets and Job Sheets.

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5-8 SMALL ENGINE STORAGE
5-9 TROUBLESHOOTING A SMALL ENGINE

TERMS USED IN INDUSTRY

Automatic Machine - A production machine that regulates itself and performs a coordinated sequence of operations.

Automation - Automatic production. The use of mechanical or electronic devices, in manufacturing, calculating or other operations, in place of human effort directly applied.

Batch Production - Batch production is the manufacture of a number of identical articles, either to meet a specific order or to satisfy continuous demand.

Batch production is necessary when the rate of production is higher than the rate of consumption.

Business - A matter or affair that engages a person's time, care and a-tention involving taking a financial risk in the buying and selling of goods or services. (Use example of local businesses.)

Capital - The money involved in starting and operating an enterprise. Land, labor and tangible goods (machines, buildings, equipment.)

Conditioning Process - Through the application of physical, chemical, or electrical action, the appearance or physical properties of a raw material are altered.

Cooperative - An enterprise or organization owned by and operated for the benefit of those using its services.

Continuous Production - An uninterrupted flow of raw material to a finished product (petroleum).

Corporation - A business organization recognized by law which operates apart from its owners. It is owned by stockholders and is controlled by the voting right which each share carries.

Enterprise - That which is undertaken or attempted to be performed; a venture. It involves the understanding of new things, new products, new methods, new personnel, policies or a new approach to any of many activities which make up a business operation.

Extraction Process - A method by which a material is separated from its source.

Factory - A facility where goods are manufactured or processed.

Feed back - (Cybernetics) Information that is sent back to the regulator of an automatic machine to make necessary adjustments. It enables the machine to regulate itself. (Example: furnace controlled by thermostat.)

Fixture - A production device used to hold the work and make it easy for the operator to locate the work quickly and hold it securely.

Industrial Arts - An area of general education that deals with tools, materials, processes, and products of industry--it is the study of the skills and knowledge of the occupations of industry which convert raw materials into useful products.

Industriology - The science of industry.

Industry - A complex organization that deals with management, production, distribution and servicing of consumer goods for a profit.

Integration - The act of combining production facilities, or doing more than a single stage of operations on a product.

Interchangeable Parts - Permitting mutual substitution (ball point pen refills.)

Jig - A production device used to hold the work and guide the cutting tool.

Labor Union - An organization of workmen working together for some common purpose.

Management - Personnel who specialize in the operation of industry who are responsible for supervision and problems that arise.

Mass Production - Producing or making things in large quantities using the principles of: (1) division of labor, (2) use of machines to make interchangeable parts, (3) use of automatic conveyors, and (4) the elimination of waste motion.

Partnership - A legal relationship existing between two or more persons contractually associated as joint owners in a business.

Proprietorship - A privately-owned and managed business.

Prototype - An original model on which something is patterned.

Quality Control - Inspection of products at various stages of production to check accuracy of workmanship and quality of materials.

Raw Materials - Substances obtained from nature (e.g. oil, timber, ore, fish, etc.) and used by industries for further processing and manufacturing.

Specialization - A division of complicated activity into simpler units for ease and speed of production.

Stock - Shares or holdings in a corporated business.

Time Study - A study of how long it takes to do a particular activity in industry.

Unit Production - (Static layout) Production of a single unit by bringing the elements of labor, materials, tools and equipment to the site of fabrication and/or production. Static layout is not necessarily needed for some unit production work.

JOB DESCRIPTIONS USED IN INDUSTRY

Plant Manager - To coordinate and supervise the activities of the plant.

Purchasing - To acquire all materials of the proper kind, at the right time, the best price and quality that the company will need for a product.

Quality Manager - To be sure that all products meet the standard that is set by the industrial engineer.

Product Engineer - To study the product, its materials and parts, specify tolerances for all parts overall quality and performance.

Production Manager - To see that production is set up and carried out with the proper techniques and procedures and also take care of all the paper work. This includes routing, scheduling, dispatching and follow up.

Industrial Relations Manager - To take care of employment, training, labor relations, health and safety, and employee services.

Finance and Office Manager - To take care of the general office staff, general accounting, cost accounting and payroll.

General Foreman - To supervise the workers and see that they get their jobs done correctly and keep them moving in the right direction.

General Superintendent - To be in charge of all manufacturing in the plant.

Maintenance Engineer - To take care of the building, grounds and equipment both inside and outside.

Information Sheet
IS 2-1

CLASSIFICATIONS OF RAW MATERIALS

- I. Non-mineral
  - A. Forestry
  - B. Rubber
  - C. Fishing
  - D. Agriculture
- II. Mineral
  - A. Metallic
    - 1. Iron
    - 2. Aluminum
    - 3. Copper
    - 4. Lead and zinc
    - 5. Tin and tungsten
    - 6. Gold and silver
    - 7. Nickel, chromium and platinum
    - 8. Uranium and vanadium
    - 9. Less common metallic minerals
      - a. Manganese
      - b. Mercury
      - c. Molybdenum
      - d. Cobalt
      - e. Titanium
      - f. Antimony
      - g. Magnesium
      - h. Beryllium
      - i. Bismuth
      - j. Cadmium
  - B. Non-metallic
    - 1. Ground water
    - 2. Coal
    - 3. Petroleum
    - 4. Rock and mineral building materials
      - a. Building stone
      - b. Crushed stone
      - c. Rock for structural ceramic items
      - d. Gypsum
    - 5. Minerals for chemical use
      - a. Salt
      - b. Borax and borates
      - c. Potash
      - d. Nitrates
      - e. Phosphates
      - f. Sulphur
    - 6. Gems and gemstones
      - a. Diamonds
      - b. Ruby and sapphires
      - c. Emeralds and other beryls
      - d. Opal
      - e. Quartz
    - 7. Miscellaneous non-metallic minerals
      - a. Mica
      - b. Asbestos
      - c. Barite

Information Sheet
IS 2-2

THE MOISTURE IN LUMBER

The usual method followed in kiln drying lumber is to determine the moisture content of the boards to be dried just before entering the kiln and at various stages of the drying process. This is done as follows: a cross section of a board 3/4 in. long is cut at least 2 feet from the end of the board. This is necessary because the wood dries faster at the end. A section cut from the end of a board would, therefore, not be a true sample of the moisture content of the middle of the board. This sample is carefully weighed on a sensitive scale, after which it is baked in a small electric oven until it no longer loses weight. The difference between the two weights is then divided by the oven-dry weight and reduced to per cent by multiplying by 100. For example, if the original weight is 195 units, and the weight after drying is 150 units, the difference in weight is 45 units. This 45, divided by 150 and multiplied by 100 gives a result of 30 per cent. During the drying process, the moisture content is calculated in a similar manner by cutting and weighing samples from the kiln.

The final moisture content varies somewhat with the purpose for which the lumber is to be used. For furniture it should be from 5 to 7 per cent; for outdoor material about 12 per cent.

Thoroughly air-seasoned wood averages 12 to 18 per cent in moisture content, depending on local climatic conditions. High grade lumber is usually air-dried for some months, before the process is completed in the kiln. The moisture content of lumber varies with changes in relative humidity of the surrounding atmosphere.

Air-dried lumber also absorbs moisture from the air until a stage of equilibrium is reached. Kiln-drying lumber will again absorb some moisture from the air, and air-dried lumber will lose more moisture if stored under heated conditions. Paint or varnish finishes do not prevent changes in moisture content, but they considerably delay the rate at which the changes take place.

BY-PRODUCTS OF TREES

Insulation and Fuel

Making every bit of the tree serve some useful purpose has long been the objective of industry. In recent times the waste from sawmills, such as slabs, shavings, sawdust, and scrap wood, has been transformed into log-shaped sticks for fuel and fireplaces, and burned as fuel in hopper-fed furnaces.

Sugar

The fibrous cell wall of wood is cellulose, which constitutes the principle substance of wood. These cells are bound together with a powerful adhesive known as lignin. These two materials, combined with water and small quantities of soluble minerals, form the basis of common wood. Science is busy finding ways to use all of the tree; as an example of its progress, we now learn that cellulose in the form of sawdust, when treated scientifically, can be made into sugar which may be used either as a food or to make industrial products.

Rayon

Scientific research has treated cellulose fiber in such a manner that rayon is extracted from the wood. Of the three types of modern rayon that are manufactured, 67 per cent have a wood base.

In the manufacture of rayon, wood chips are reduced to a pulp and mixed with chemicals. This forms a jelly-like substance. This mass is forced through tiny holes in platinum sieves to form hair-like strands. These are twisted together to form yarn of the desired size.

Rayon is expecially suited for the manufacture of the cords which form the fabric of pneumatic tires used in automobiles and aircraft.

Experimenters have discovered that by shredding the bark of one of the western trees, a fiber capable of producing an ideal new felt-type material can be obtained. Mixed with a certain proportion of wool, the new fibers can be woven into a warm, serviceable cloth.

A similar fluffy material produced from bark which has long been considered waste has been refined into an effective insulating material.

Wood Plastics

New processes for developing plastics are being discovered all the time. The lignin adhesive is the principle ingredient in many modern plastics. The various chemicals are added to harden the plastic. Fountain pens, automobile dashboards, steering wheels, many hardware items, and the future production of plastic-bodied automobiles are but a few of the many products which this fascinating industry is now developing.

Products Extracted From Trees

Valuable products are extracted from the tree itself in addition to those made from parts of the tree. Solvents, dyes, drying agents, and spirits necessary in a multitude of manufacturing processes are a part of the forest storehouse.

Southern pine trees yield oleoresin for the paint industry; turpentines and resins extracted from oleoresin are employed as dryers and solvents for paint, varnish products, and printing inks. They are also important parts of soap, paper, and many other articles.

Turpentine and resin are obtained from an extract which is the product of a molasses-like substance that drips from the tree after the bark and outer wood have been shipped. Distillates, such as wood alcohol and acetone, and several important chemicals are other by-products of trees. Dyes extracted from hemlock bark are used for leather tanning.

THE PAPER INDUSTRY

Credit for the invention of the paper making process is usually given to Ts' as Lun (first century A.D. China). It is believed to have been made from flax and hemp. Considerable technological progress was made during the Industrial Revolution. The outstanding invention was the first paper machine built in England by Henry and Sealy Fourdrinier.

Paper is defined as a matted or felted sheet of vegetable fiber formed on a screen from a water suspension.

All paper is derived from cellulosic fibers. About 90 per cent comes from trees; both coniferous and deciduous trees are used. The coniferous used are spruce, hemlock and pine. These have long fibers and give strength to the product. The deciduous have short fibers and impart opacity and smoothness to paper. Rags are sometimes used to give the paper strength. To insure a continuous supply of trees, tree farming is becoming more important in the paper industry.

As to the use of paper, it is usually classified as cultural or mechanical. The cultural are those papers used in writing and printing. The mechanical is all paper not used for printing purposes, such as wrapping paper, facial tissues, napkins, toweling, etc.

The paper industry has come a long way since the early 1800's when Nicholas-Louis Robert of France invented--and the Fourdrinier brothers in England patented--a machine that would produce paper on an endless wire screen. The principle of papermaking has remained the same, but the methods, quality, volume and variety of the products are vastly different from those days.

When does the process begin? It begins in the woodlands where trees designated as pulpwood are cut into prescribed lengths, measured in cords and hauled from the forests to the woodyard of the paper company.

Then they are placed on fast moving conveyor belts and fed into a giant, revolving drum barker which, assisted by jets of steam or water, strips away the bark and cleans the wood. Moving on, the chipper, a revolving disk with heavy sharp knives set at an angle, quickly reduces the logs to millions of woodchips the size of breakfast cereal.

Once again, the wood, in chip form, travels on conveyors to ten story high, rocket-like digesters or "pulp cookers". Chemicals and steam are added and combine to break down the chips into soggy globs of cellulose and other elements of the tree. The chemicals are now removed, along with the lignin and resins, leaving the cellulose fibers to be processed still further.

The fibers, now called pulp, pass through many cleansers and screens to prepare it for the bleaching process which will give it the whiteness and brightness needed for the grade of paper being manufactured. Once bleached, the pulp is ready to have dyes, pigments, sizing or resins added, called the furnish, which provide the paper or board with the appropriate finish.

The pulp, roughly 99 per cent water and 1 per cent fiber and furnish, is ready to be introduced into the Fourdrinier paper machine through a headbox which stretches across the machine. Pumps spray a thin film of fibers onto the fast moving endless screen. As it travels along the wire, the water drops away and the fibers are matted into paper. Although still damp, the formed paper is picked up by and travels through a maze of hot rollers which press and dry the paper. From here it is rolled and cut into various sizes.

CHEMICAL COAGULATION

Chemical coagulation is the process of changing from a liquid to a thickened curdlike state, not by evaporation but by chemical reaction. Once this thickening action takes place, the molecules cannot be dispersed back into their original condition.

The small molecular particles are held in suspension in the solution but when in contact with heat, acid, salt, or alkali, the molecules group together to form larger clumps, which can be screened out or separated from other liquids.

Chemical coagulating is used in various industrial processes. The basic idea in using this process is to group together small molecules, which cannot be filtered out because of the smallness, into larger particles which can be screened or filtered out of the solution.

Examples of Use

1. Raw rubber is removed from the latex collected from rubber trees by adding a weak acid solution. The rubber is then rolled and washed for further processing.
2. Water is purified by adding aluminum sulphate (alum) to the water. The alum tends to group together the suspended sediments into larger particles to allow settling and filtering of impurities. Many of the sediments are removed by this process but it does not guarantee pure water.
3. Aerosol spray cans play an important part in our culture of convenience today. Many of these cans work on colloid action. Other applications where coagulating plays a part are: the curding of milk in cheesemaking, the thickening of an egg when heated, and pollution control to remove impurities from the waste water.

Information Sheet
IS 2-8

CASTING METALS

Methods of Casting

A casting can be simply defined as a molten material that has been poured into a prepared cavity and allowed to solidify. Although the principle is simply stated, great skill and long experience are required to gain the knowledge and master the techniques to produce quality castings on difficult jobs.

Many casting processes have been developed over the years to fulfill specific needs of finish, accuracy, speed of production, etc. These processes include sand casting, shell-mold casting, plaster-mold casting, investment casting, permanent-mold casting, centrifugal casting, and die casting.

Sand Casting

Sand casting is used primarily for steel and iron, but it can be used for brass, aluminum, bronze, copper, magnesium, and some zinc alloys.

This is the most widely used molding method. It utilizes a mold made of compressed moist sand.

Shell-Mold Casting

The shell-mold method of producing castings is basically a modification of the sand-mold process. It had its early development in Germany during World War II. Instead of using the regular foundry-sand mixture which has clay and water as binders, a fine dry sand mixed with phenolic resin is applied to a pattern which is heated to approximately 450 degrees F. The resin melts and flows in between the grains of sand acting as a bond. This feature, plus curing on the pattern, produces a hard, smooth mold which is just as accurate as the pattern itself.

Plaster-Mold Casting

Plaster-mold casting is somewhat similar to sand casting in that only one casting is made and then the mold is destroyed.

Metal-casting plaster is a specially formulated mold material for casting non-ferrous alloys. Its main ingredients are 70 to 80 per cent gypsum plaster and 20 to 30 per cent fibrous strengthener. Water is added to make a creamy slurry.

Investment Casting (Lost-Wax method)

Investment casting is a specialized process often called the lost-wax method. It was used centuries ago in China and Japan to produce beautiful statuary. Basically, it consists of pressing wax or plastic into a split metal mold. Molds that are not difficult to fill may be poured by gravity, as in greens and molds.

Permanent Molding

One distinct disadvantage of the sand-casting processes is that the mold is destroyed each time it is used. It is natural that attempts would be made to make permanent metal molds. In the Middle Ages, iron molds were used to produce pewterware, such as cups, pitchers, and other utensils.

Permanent molding includes two main types--die casting and permanent-mold casting.

Die Casting

Die casting refers to both the process and the product. Die casting is generally considered a one-step process because molten metal is converted in a matter of seconds from fluid into a finished or semi-finished product.

Information Sheet
IS 2-9

MINING METHODS

Quarry, opencut, or stripping operations are operationally the simplest form of rock mining. The surface overburden, if any, may be removed by using hydraulic washing or dragline scrapers, dragline excavators, clamshell buckets, or power shovels to expose the underlying mineral deposit. The deposit is then usually blasted into manageable sizes and loaded by the same type of dragline, shovels, buckets, or conveyors into tramcars, trucks, or railroad gondolas. If the excavation is deepened, the approach to the lower levels may become an important element of design. The approach may be a spiral roadway, by successive ramps between horizontal levels.

Placer mining is a term applied to a special kind of mining, allied to open-pit operations. It is used for poorly consolidated minerals, particularly those of stream deposits, ocean beaches, and dunes glacial deposits. The essence of placer mining is transporting the materials from river or other source to the concentrating plant by hydraulic flushing, by bucket or dragline dredge, or by hand methods. The material is then commonly washed through riffled sluices or troughs which may be supplemented by other cleaning devices such a jigs or spirals.

Room-and-pillar mining is applicable especially in working bedded mineral deposits if they have great extent horizontally but relatively little thickness. This method is well adapted to mining beds of coal, rocksalt, limestone, phosphate rock, iron ore, sedimentary manganese ore and similar bedded deposits. An approach can be made by vertical shaft or incline shaft.

ORE SEPARATION BY FLOTATION

Flotation is the process of separating different minerals from each other by floating certain minerals to the surface while unwanted particles remain behind.

The process of flotation is easily understood. The ore which is to be separated is first ground to a fine powder in ball or bar mills. The ore is then mixed with water and a reagent, which is usually pine oil. The mixture is then pumped into a flotation tank and agitated rapidly. Compressed air is then forced into the bottom of the tank to form large ascending bubbles. The metal bearing parts of the ore are attracted to and attach themselves to these bubbles. When the bubbles reach the top of the flotation tank, they are heavily coated with metallic minerals. These bubbles, or froth, are removed and the ore particles are filtered to separate them from the water of the bubble.

The flotation process has become important in the separation of ores because of its low cost and high recovery rate. Many metals are separated partially or completely from their ores by flotation. These include copper, lead, zinc, gold, and silver. Flotation is being used in the benefaction of iron ores on an experimental basis.

Information Sheet
IS 2-11

DESALINATION OF WATER

Earth is the water rich planet of our solar system; it is blessed with tremendous quantities of water. Without water, life as we know it could not exist. Water often makes or breaks the destiny of a community, metropolis, or nation. Abundant quantities and high quality water invite settlement, agricultural pursuits, and industrial activity. Water promotes trade and provides power.

However, 99 per cent of all surface and ground water is either salty or locked up in the form of ice in the polar regions. Most of the small fraction of remaining water is fresh water. Some is trapped as ground water at depths of less than 2,500 feet, and smaller amounts are distributed for various periods in soils, lakes, rivers, and the atmosphere.

In most areas of the world today, there is an adequate supply of fresh water. However, it is predicted that future demands for fresh water will far exceed the amount of fresh water which will be available.

The ever-increasing use of water is due to the rapidly increasing population, rising living standards, industrialization, expansion of irrigation agriculture, and the fact that an increasing amount of the population lives in arid and semiarid parts of the world.

The problems of availability of water in sufficient quantities and quality are of world wide importance. The problem consists of several interrelated problems involving social, technological, and economic factors.

One of the most promising solutions to the water problem lies within the oceans which offer an inexhaustable source of water. Even the saltiest sea water can be changed into perfectly pure water. The process in known as desalination.

Saline water conversion is in its infancy, although well over 50 million gallons per day are being produced from saline sources. The cost of the process has been drastically reduced over the last 10 years, but it is still relatively high (costs have been lowered from about $4/1000 gallons of fresh water to approximately $1/1000 gallons). The lowering of desalination costs will have a tremendous effect on the future use in aiding the solution of growing water problems. Some large desalination plants are presently in operation. These plants are located in the United States, Cuba, Kuwait, Venezuela, Italy, Israel, and the Virgin Islands.

Hundreds of desalination processes have been suggested. All of these processes are classified in one of two categories: processes which separate the water from the solution and processes which separate the salt from the solution.

One of the most effective processes of desalination involves principles of distillation. In the distillation process, the saline water is heated to its boiling point. When the water reaches a temperature of 212° Fahrenheit, it boils and escapes as steam. At this temperature nothing happens to the salt and it remains in the solution. The escaping steam is then cooled, which changes the steam into pure water. If the process is continued until all water has been driven off as steam, you will find that you are left with salt and other minerals which were originally dissolved in the sea water.

The future use of sea water is promising. In addition to obtaining fresh water from the sea, we may someday be able to economically remove some of the vast mineral deposits which sea water contains.

Information Sheet
IS 3-1

HISTORY OF MANUFACTURING

The earliest U. S. manufacturers centered their colonial industries around the problem of living in a raw unsettled country. Food, lumbering, and shipbuilding occupied the early colonists. The industries were held in the household and village shops of simple craftsmen who worked hard to turn out the necessities and rarer luxuries demanded by the pioneer people.

The second stage of manufacturing development began when the U. S. was cut off from foreign competition by its own protective legislation and by the War with England. This period was approximately from 1800-1860 and centered largely about manufacturing having to do with the settlement of the country and the exploitation of natural resources.

The third stage of development involved the expansion of the factory system. The factory system brought the several processes of manufacturing under one roof, centralized and increased the use of power, introduced specialized tools and machines, and hired workers for fixed wages and hours. Individual proprietors and partnerships owned the greater part of these enterprises and capitol came partly from the slow process of accumulation and partly from sources abroad.

The fourth stage constituted an industrial revolution, which was uniquely American. What took place between 1890 and 1930 was much more than the further growth of the factory system; it was a complete transformation of the whole field of industrial production. By the introduction of new sources of power, notably the electric dynamo and the gasoline engine, power was specialized and brought to work instead of the work having to be taken to the power, as was largely the case with steam power. A whole series of new inventions came into wide everyday use, such as the telephone, auto, motion pictures, radio, airplane, and automatic machine tools. These inventors revolutionized communication and transportation, amounting to a conquest of time and space hitherto undreamed. This period is known as the scientific and technological revolution.

LOCATION OF MANUFACTURING

When analyzing the various reasons why manufacturing is located at a particular place or why it has remained at that location, a combination of factors is usually found.

In order to successfully operate a manufacturing industry, ten primary components must be considered before the selection of a building site is determined. These ten components are as follows:

1. Raw materials - The availability of raw materials is usually a major location factor. For example, the early woolen mills were located in New England, where wool from the local sheep industry was available.

2. Power and Fuel - No matter what method of power is used, the cost of its transportation must always be taken into consideration. Therefore, the nearness to a source of power is essential. Where large quantities of fuel are used as a basic raw material, the manufacturing processes are frequently oriented to the fuel source.

3. Market - As a locative factor in manufacturing, the market is increasing in importance. Plants are usually established where a transportational advantage insures access to a substantial local market and where a good competitive position is maintained to serve important adjoining market areas.

4. Labor - Vital factors in every manufacturing industry are the cost, availability, stability, and productivity of the labor supply. The growth and future of any manufacturing industry are jeopardized if these labor factors are not favorable.

5. Transportation - The location of a manufacturing industry in any given area may depend directly on the type of transportation present. As transportation has become more efficient, cheap and dependable, the tendency for manufacturing to concentrate in these areas providing better transportation has greatly increased.

6. Capital - Through the use of corporate finance, the importance of local capital has been greatly reduced. In these modern times the location of important manufacturing industries are selected with little regard as to the source of money for their development.

7. Climate - The climate of a region has direct influence on costs of a manufacturing industry. In the U. S., the warmer regions have a comparative cost advantage over colder areas.

8. Water - As a localizing factor, water has become of increasing importance in recent years. Locating near an adequate supply of water is a necessity in choosing a site for such manufacturing industries as iron and steel, pulp and paper, food and chemical processing, and wool scouring.

9. Taxes - It is difficult to evaluate the influence of a tax structure on the localization of a manufacturing industry. The importance of taxes tempers the impact of local taxes.

10. Government - Local, state or national can play a decisive role in the establishment of manufacturing industries. During periods of national emergencies, such as wars, governmental influence is demonstrated in a number of ways. As our American economy becomes more highly urbanized, communities depend increasingly on manufacturing industries to maintain themselves.

SPARK TESTING MANUFACTURED METALS

The art of spark testing, an ancient art which recently has been developed into a modern industrial science, can be profitable to every company which produces, finishes, fabricates or warehouses metals.

The sparks emitted from a piece of metal will help identify the metal just as well as some destructive tests. These sparks are called a stream.

Various aspects of a stream need to be studied when spark testing. These aspects tell various things about the material and will give a basis on which you can identify the material being tested and its content as far as materials are concerned.

1. Overall appearance of stream -- generally concerned with the length and width of it and is basically the same for most steels with plain carbon.
2. The carrier lines--where and how the material is removed by the grinding wheel. The way it flies off.
3. The type of burst--tells carbon content by the way the burst is at the end of the pattern.
4. The density--tells density if observed at the center of the stream, and varies with the amount of carbon.

Variables of sparking alloy steel:

1. Characteristic
2. Color Effect
3. Effect of one element upon the stream

(1) Characteristic

Carbon - general stream, type of bursts, carrier line, density of stream

Manganese - makes carrier lines thinner

Phosphorus - small blunt attached spearpoint

Sulphur - bright swelling in carrier lines

Silicon - white dot or dash in carrier lines

Nickel - white dot or dash in carrier lines or white dot at base of carbon burst

Chromium - perfectly formed white star at end of carrier lines.

Molybdenum - well defined detached spearpoint.

(2) Color Effect

Brighter	Darker
Manganese	Nickel
Chromium	Molybdenum
Sulphur	Silicon
Titanium	Phosphorus
Columbium	Tungsten

(3) Effect on other elements

Manganese - makes carrier lines thinner and emphasizes the silicon dash

Phosphorus - tends to reduce carbon appearance

Silicon - markedly reduces carbon bursts

Nickel - reduces carbon bursts

Molybdenum - reduces carbon bursts; when present with nickel, it modifies the well defined nickel dash by causing it to appear as a swelling

Chromium - emphasizes carbon bursts.

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THE TEXTILE MANUFACTURING INDUSTRY

Textiles have affected the political, cultural, military, and even religious aspects of the life of man. Wool was the basis for the prosperity of the most important medieval city-state in Italy and Flanders, and for the rise of England as a commercial nation. More recently it has become the mainstay of the Australian economy.

Silks have ranked with jewels and spices as the most coveted imports from the East since the days of the Roman Empire. Silk played an important part in the transformation of Japan from a feudal to a modern nation.

Cotton was such an irresistable import in the 18th century Europe that it contributed to the downfall of the mercantile system. In the South of the U.S. the replacement of tobacco with cotton served to perpetuate the slave system, perhaps, making the Civil War inevitable.

The first factories were built to make textiles. The first processes of mechanization were applied to the manufacturing and processing of textiles. Their production and distribution were the first to be organized on a capitalistic basis. The desire to produce textiles quickly, cheaply and in enormous quantities was one of the main causes of the Industrial Revolution.

Following World War I, the introduction of manmade fibers became a commercial fact instead of a laboratory experiment. From 1925 to 1935 rayon became a major factor in a changing concept of textile fiber processing. Rayon could be successfully woven on the mechanized cotton looms and could compete with the more expensive silk fabrics at a price advantage.

Shipments of silk from Japan were cut off by World War II. The introduction of nylon completely removed the demand for silk. After the war the use of silk extended from hosiery and clothing into home furnishings and industrial needs.

Information Sheet
IS 3-5

THE FOOD MANUFACTURING AND PROCESSING INDUSTRY

The key function performed by the modern food industry is that of processing foodstuffs in such ways as to preserve them from the time of their harvesting to the time of their consumption.

Food processing is commonly understood to include canning, bottling, freezing, and dehydrating, which permit foods to be stored; changing the form of the food, as in making preserves from fruit; or simply cooking food as in baking bread.

Napoleon appreciated the nutritive value of succulent vegetables and fruits and made the statement that an army marches on its stomach. He offered a 1200 franc prize for a process of preserving food. Nicholas Appert is credited with the system of using glass containers as cans and corks to seal them while boiling the contents. About 50 years later Pasteur showed the relationship between food spoilage and bacteria.

At the close of the 19th century the modern open top tin can was developed. The success of the canning industry is hinged to the economic modern can which is now made at the rate of more than 400 per minute on each line.

THE CHEMICAL MANUFACTURING INDUSTRY

The chemical industry is classed as a relatively new industry, although some basic chemical processes have been known for many years. Up until the time of World War I, the Germans were the sole suppliers of essential chemical products such as drugs, dyes, etc. When the war cut off this supply, the United States government subsidized the research into chemistry and later, seizure of German process secrets put the United States into the industry.

The chemical industry is divided into three major groups as listed below:

1. The purely chemical group, such as sulphur, coal chemicals, soda ash, etc. As a rule, these commodities are bulky and the industrial plant tends to concentrate near the source of supply to conserve the transportation costs. Most of these products are used as they are extracted from the earth and need very little purification for general use.

2. The allied process industry is that industry that uses some of the chemicals as ingredients in their products. This industry would be one that makes paint, soap, plastics, fertilizer, etc.

3. The chemical process industry is that industry which uses chemicals at one or more stages of an operation in manufacturing. This would include such areas as the manufacture of rubber, glass, paper, leather, etc.

The rapid expansion of the chemical industry has increased all through the country but the major increase has been in Texas, the Ohio River Valley, and the Southwest.

Information Sheet
IS 3-7

THE MANUFACTURE OF SYNTHETIC MATERIALS

Since the French chemist Berthelot's day, more than 400,000 new combinations of molecules have been constructed. Millions are theoretically possible. Some are exact duplicates. Other so called synthetics have properties similar to those of natural products which enable them to be used in their place as is rubber.

No materials in nature even remotely resemble such familiar and useful synthetics as the drugs aspirin, barbital and the fibers Celanese and nylon; the dye methyl violet; the plastics celluloid, bakelite or lucite.

By constant use we have stretched the meaning of that up-to-date word "synthetic" to cover a great many materials that really belong to a number of different categories. But all of them are man made molecules. There is much more behind these new synthetic chemical products than just pretty ashtrays, neat electrical gadgets, runless stockings and chipless automobile finishes.

Little more than twenty years ago plastics were still widely regarded as cheap substitutes for traditional materials such as wood and porcelain. Today this attitude toward plastics has been swept away, and plastics have established themselves as wonderful new materials in their own right. They have ousted older materials from many applications but they have done this because they can do a better job often at lower cost.

Acrylic plastics, also known as Lucite and plexiglas, possess crystal clarity and maximum colorability. They were first manufactured commercially in 1931 as coating materials and for bonding safety glass. The original acrylic was developed by Dr. Otto Rohm of Germany in 1901.

A most valuable property of the acrylic resins is their ability to weather where they maintain stability better than most other plastics. High scratch and abrasion resistance improves its serviceability as a lens material for instrument lenses. Many automobile tail and stop lights use ruby acrylic molded lenses. Acrylics withstand food oils, nonoxidizing acids, petroleum lubricants and household alkalies. They are extensively used in photographic solutions. They are slowburning and with certain additives become self extinquishing. This makes them highly rated in building codes and insurance plans.

Widely used applications for acrylic plastics include lenses, aircraft and building glazing, lighting fixtures, dishes, piano keys, knobs, dials, name plates, telephone dials, beverage dispensers, display cabinets, signs, skylights, packaging and textile fibers.

Some synthetic materials:

1. Acrylonitrite - made from ethylene
2. Butadiene - petroleum gases, coal, coke, ethyl alcohol and butylene glycol. Limestone - acetylene
3. Chloropreme - lime and coke
4. Isobutylene - gases from refinery cracking processes
5. Isopreme - a product of destructive distillation of natural rubber
6. Styrene - benzene and ethylene or ethyl alcohol

Some types of synthetic rubber:

1. Buna-S - made from butadiene and styrene
2. Butyl rubber - isobutylene
3. Neoprene - chloroprene
4. Perbunan - Buna-N - butadiene and acrylonitrite

Information Sheet
IS 3-8

THE STORY OF THE PLASTICS MANUFACTURING INDUSTRY*

Plastics rank today as one of the few billion dollar industries in the United States. It is, too, one of the fastest growing, with almost 200 per cent increase in production in the last ten years.

As the plastics industry has grown both in volume and in variety of materials, each with special properties, business men and industrialists in growing numbers have sought information on how plastics can improve their products, cut their costs, and streamline their production. Students, technicians and workers have sought facts on employment opportunities, plastics courses offered by colleges and trade schools, and supplementary information sources.

The growth of the plastics industry has been so rapid, however, that public awareness of the sources of information on the major plastics, their characteristics and proper use has not kept abreast of the interest of either the businessman or the student.

The content of this information sheet will help you find answers to some basic questions about the plastics industry, its materials and production methods.

How the Industry Grew:

As recently as 98 years ago there was no such thing as a commercial plastic in the United States. We had not learned that by combining such basic organic materials as oxygen, hydrogen, nitrogen, chlorine and sulfur, new man-made materials could be created--materials which, through variations in the amount and combination of basic organic and inorganic ingredients, could be made almost any quality desired in an end product.

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*Reprinted in part from Masson, Don. The Story of the Plastics Industry. New York, New York: The John B. Watkins Company, June, 1966. pp. 1-8.

Called Celluloid, this first American plastic was soon found to have many uses. Colored pink, it was quickly adopted by dentists as a replacement, for hard rubber in denture plates. It will be remembered as the material from which wipe-clean collars, cuffs and shirt fronts were made, and as the window curtains on the early automobiles. The first photographic film used by Eastman was made of Celluloid in the 80's to produce the first motion picture film in 1882.

Forty-one years were to pass before the plastics industry took its second major step forward. In 1909 Dr. Leo Henrik Baekeland introduced phenol-formaldehyde resins. While others in the field of chemistry had experimented with the combination of phenol and formaldehyde, Dr. Baekeland was the first to obtain a controllable reaction between the two. The first phenolic in this country was given the trad emark, Bakelite, coined from his name.

Dr. Baekeland was also the first to develop techniques for converting this plastic to commercial use. His patents covered the production of a phenoic that could be cast (like marbleized clock bases), a compound that could be formed under heat and pressure (like an electric iron handle), and solutions that could be used in making laminates (like restaurant table tops).

From 1909 to 1926 two more plastic materials were developed--cold molded and casein. Cellulose acetate was the next large-volume plastic to be developed commercially in this country. Launched in 1927, it was available only in sheets, rods and tubes until 1929 when it appeared as a molding material and became the first injection-molded plastic.

The first of the vinyl resins, polyvinyl chloride, came on the market in this country in 1927. The vinyls now constitute quite a family of resins, the most important of which--besides polyvinyl chloride--are polyvinyl acetate, polyvinyl chloride-acetate, polyvinyl acetal, polyvinylidene chloride.

While polystyrene became commercially available in this country in 1938, it is one of the oldest synthetic resins. It dates back to 1831 when it was first isolated. Today, polystyrene is one of the volume plastics, most familiar in toys and housewares.

Polyethylene was introduced in 1942. It was originally produced in England and first made in the United States for the U. S. Navy as an important electrical insulation. Polyethylene became the first plastic to reach a billion pound annual production rate.

The plastics industry runs into billions of both dollar volume of finished products and in the pounds of raw material produced. Three plastic materials have reached or exceed 2 billion pounds annual production; Polyethylene--3 billion. The Society of The Plastics Industry, Inc., predicts that the production of all synthetic plastics and resin materials in 1966 will be about 12,600,000,000 pounds. This fact, alone, is indicative of the importance of the plastics industry in our world today.

Plastic companies numbering over 5,700 are located throughout the United States. Approximately 50 per cent are in the East, 34 per cent in the Midwest, 13 per cent on the West Coast, and 3 per cent elsewhere.

THE PETROLEUM MANUFACTURING INDUSTRY

Crude oil has been known to man since biblical times when it was used for a fuel and medicinal purpose. It has been recognized as a valuable commodity to our way of life since the turn of the century. Technical advances have opened the door for a wide and varied field of products derived from or directly related to various components separated from the basic crude oil.

Crude oil is of little use to us until it is refined. This oil, as it is extracted from the earth, is transported to the refinery by means of a pipeline. In the refinery the crude oil is broken down or transformed into many useful products. These products, most of which you are familiar with, are gasoline, kerosene, alcohol, wax, oil, grease, medicine, roofing material, and chemicals used to make other products such as synthetic rubber, plastics, etc.

The chief refining methods are briefly discussed below:

1. The fractional distillation method is simply a physical separation of the crude oil components at different boiling temperatures to produce a range of products from heavy bottoms, lube distillate, gas oil, diesel oil, kerosene, gasoline, etc. The chief disadvantage of this process is that a demand for one product may cause an over-supply of other products.

2. The thermal cracking method was discovered in 1911 by Mr. B. M. Burton. If heat and pressure were applied to kerosene and similar products, the molecular structure would change and you would end up with a high octane gasoline. This discovery had the effect of doing away with an over-supply of some products as listed in the process above. One-fourth of our domestic fuel is obtained from this method.

Petroleum products may also be obtained from sources other than crude oil and, although not used very much, they do serve as a vast storage area of petroleum if ever needed. Listed below are some of the sources for obtaining petroleum.

1. Extraction of oil from natural gas through a cycling process. The gas is hot as it comes from the well under 3,000 lbs. per sq. inch. As it is passed through a set of cooling towers, the liquid is extracted in separators and the dry gas is then often pumped back into the well to maintain pressure for a continuous flow.

2. The extraction of petroleum from coal or coke is a simple process of directing alternate blasts of air and steam onto the coal. This causes a chemical reaction which in turn produces a variety of petroleum products.

3. The extraction of petroleum from shale by the use of a special retort burner. The shale is extracted, then ground into three-inch chunks and put into the burner. The oil in the rock melts out, thus separating the materials. The potential for future use of this process seems enormous with the huge reserve of shale known to us.

4. The extraction of petroleum from tar sand by the use of a centrifugal separator or the development of a new method which uses an atomic blast to heat the sand which will allow the oil to flow freely for extraction.

This industry is becoming highly mechanized and demands well educated technicians. In spite of the industries' lack of research expenditures, they seem to be growing and advancing by leaps and bounds. This is somewhat due to the fact they are integrating into the field of synthetics, which is a growing field.

Information Sheet
IS 3-10

THE PRINTING AND PUBLISHING INDUSTRY

From the very earliest time, men have endeavored to establish a graphic record of their achievements. It was not until about the time of Columbus that the basic process of printing, as known today, was actually practical. It is difficult for us to imagine a time when men had no knowledge of paper or of any of the present writing or printing materials and methods. Yet this was a condition that existed among all the primitive peoples.

The early Egyptians are given credit for giving us one of the most important contributions in the printing industry--PAPER. After the making of paper (called papyrus) parchment made from animal skins was used for printing.

One of the earliest methods of graphic communications was that of making pictures or symbols to convey a message. The most prominent were hieroglyphics. But, long before the birth of Christ, the Phoenicians introduced a simple set of phonetic characters. This alphabet consisted of twenty-two letters. From these the Greeks and Anglo-Saxons made modifications from which came our present alphabet of twenty-six characters.

Early printing, as compared to our present day printing, originated in the Orient by the Japanese. The printing was done with hand-carved blocks of wood; the stamping on sheets of paper occurred as early as 1417. About the middle of the fifteenth century the demand for books steadily increased. The most successful movable-type press was invented by Johann Gutenberg, who printed the Bible about 1456.

The divisions of graphic arts are photography, printing, engraving, etching, electrotyping, bookbinding, stereotyping, and drawing. The printing industry is the largest and most active section.

In the U. S. today there are between 40 and 50 thousand printers engaged in the printing industry. These industries vary greatly in size. Only about 40 companies are considered large. The new web offset presses are vary expensive and can only be used economically on vary large jobs. Some offset machines cost approximately one-million dollars. The big demand for employees will be in the offset field for lithographers, bindery operators and press technologists. A pressman will have at least 2 years training while a lithographer will have a minimum of 4 years.

Current census reports list printing as the second largest American industry with respect to its number of establishments. It ranks seventh in total salaries and wages paid, with an annual payroll over $2.5 billion. Printing ranks eighth in the value added by manufacture. In number of employees it ranks ninth with nearly 900,000 workers. Printing is truly a great industry, with a vast array of skilled craftsmen.

Screen printing is believed by some to be the oldest form of printing. Screen printing is a stencil process which is familiar to everyone. This process is widely used commercially to print small quantities which would require expensive plates in other methods of reproduction. It is especially adaptable for printing on such surfaces as metal and masonite and on difficult surfaces as bottles and other containers. The equipment is generally low in cost as compared to other printing methods.

The following are just a sample of the users and uses for the screen printing process:

Machinery Mfrs. -- To screen names and directions onto the machines.

Aircraft Co's. -- To screen numbers and insignias on plane parts.

Real Estate Co's. -- To screen "For Sale" and "For Rent" signs.

Textile Co's. -- To screen patterns and designs on clothes, handkerchiefs, towels, tablecloths, etc.

Candy Mfrs. -- To make their own displays, signs, shipping cases, etc.

THE RUBBER MANUFACTURING INDUSTRY

The bale of latex, which varies in rubber content from 30 to 45 per cent, is diluted to a uniform consistency of 20 per cent. Upon arrival at the rubber plant, the bale is cut into quarters for ease in handling. The crude rubber, as it is shipped, has little commercial value. It cannot be easily fabricated, as it becomes soft and sticky when heat is applied and hard and brittle in extreme cold.

To improve its quality, the crude rubber must first be washed and made pliable in a "cracker", a machine similar to a large washing machine wringer. Then the rubber is broken down by a process called plasticization, which is performed in a rubber mill. The tough crude rubber is shredded by rolls and is masticated until it becomes pliable and sticky. This operation can also be performed in machines such as the Gordon plasticator, which works like a huge sausage grinder, thoroughly mixing and blending the material.

The next phase is compounding, either in the rubber mill or in huge two-story machines called Banbury mixers. The Banbury holds a much larger quantity of the materials, up to 500 tons, and thus are preferred for large-scale operations. Compounding is simply the thorough mixing of batches according to rigid formulas. The principle compounding agents that induce chemical change are classified as accelerators, activators, retarders, antioxidants, plasticizers, and the most important ingredient for vulcanization--sulphur. Other compounding agents such as reinforcers, inert fillers, coloring agents, softeners, and stiffeners produce physical changes. Reclaimed rubber also can be added at this point. This reclaimed rubber is previously treated so that impurities are eliminated and the product is replasticized. Most scrap is used only when the finished product requires considerable tensile strength and resistance to abrasion.

After compounding, the sequence of operation varies according to the product desired. Thicknesses of 0.003 inch to 0.1 inch can be obtained in this manner; if a greater thickness is desired, fabric is frictioned, that is, impregnated with rubber. The fabric and the rubber are passed through a series of rolls in such a manner that the rubber is squeezed into the weave of the fabric. Some cloth is merely coated--that is, the rubber is only spread over the surface of the fabric.

Vulcanization, which follows compounding and shaping, cures the rubber and imparts certain desirable qualities to it. The curing consists of adding a specified quantity of sulphur, from one to five per cent for soft rubber and up to 45 per cent for hard products. Other ingredients, as previously stated, are also added. The compounded substance is then heated in temperatures of from 230°F. to 290°F.

More than three-fourths of all rubber consumption is in the form of tires and tubes. In the tire-making process, lengths of rubberized cord fabric are placed in layers upon a revolving collapsable drum. These plies are cut on a bias so that each layer's cords run at right angles to the preceding layer. After the second layer has been wound on the drum, a bead of high-carbon steel wire is inserted over each end. The fabric is rolled over and successive plies are added. After chafing strips have been placed around the bead, the tread and sidewall are put on in a single piece. The drum is collapsed. An air back is inserted into the tire and the unit, after being shaped in a special machine, is put into a vulcanizing press. The heat and pressure of this process give the tire the desired form. The inner air bag, filled with steam or hot water, supplies the heat and pressure that cure the tire. Less than an hour is consumed by this operation.

The Bag-O-Matic, a machine that combines the last three operations--shaping, vulcanizing, and removal from the mold--has further cut production time. An earlier technological advance was the merry-go-round. This is a tirebuilding machine with 13 work stations. The employees stay at these positions while the work in process is automatically conveyed to and from the designated locations. The merry-go-round has proved to be a significant advance over the older manual methods.

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LEATHER MANUFACTURING

Egyptian records show that man first made leather 5,000 years ago. Articles made of leather 3,000 years ago have been found in Egyptian tombs well preserved. Because of the condition of these leather articles, much could be learned from studying them.

The Colonists found the American Indian using leather articles when they arrived in this country. Early cavemen also used leather for footwear and clothing. The Indian's leather was called buckskin. The colonists soon learned to use leather for other necessary articles such as hinges, coach springs, and fire buckets.

The Hebrews used a method of tanning in which oak bark was used. It became known as the vegetable tanning process. In the late 18th century machine and chemical advances made it possible for leather to be produced in greater abundance.

Leather is classified by its size. These are: (1) hides - come from horses and cows, (2) kips - come from colts and calves, and (3) skins - come from sheep and goats.

Leather must be kept from spoiling before the tanning process begins by either refrigeration or salting. Leather in this state is referred to as green leather. There are three distinct processes in leather manufacturing. They are: (1) preparation for tanning, (2) tanning, and (3) finishing. The two different methods of tanning are vegetable and chemical.

Information Sheet
IS 3-14

THE MANUFACTURING OF GLASS

Glass is thought of as a hard brittle substance, usually transparent. The housewife thinks of glass as a window, a casserole dish, or other household item. The chemist thinks of it as a reagent bottle or a chemical flask. These associations are essentially correct but neither of them gives a true definition of glass. To better understand glass, it should be thought of as an unusual type of material that has a temporary atomic structure much like that of a liquid which somehow has been frozen in place so that when we see it or feel it, the glass appears to be (and is) a very solid and permanent substance.

The use of glass goes back before recorded history. Primitive man used "natural glass", called obsidian, for arrowheads, knives and other primitive weapons. Later cultures made jewelry, mirrors and ceremonial masks from the black translucent material.

Archeologists have reported that glass beads were made in Egypt around 3000 B. C. but it is thought the Egyptians acquired their knowledge from Mesopotamia. In approximately 1570 B. C. Egyptian craftsmen learned to make small containers by dipping hard-packed sand cores into molten glass until the mold was thickly coated.

The Syrians are given credit for the discovery of glass blowing which revolutionized the art of glassmaking as much as the gasoline engine did the automobile.

Rome became the leader in glass manufacturing after its conquest of Egypt. Glass began a 400-year period of development and growth. Windows were made for the first time by pouring molten glass on a sanded stone, then pulling it flat and thin. Later, Roman craftsmen learned to blow small cylinders which were slit open and flattened to make panes.

The Syrians, about 650 A. D., made flat sheet glass by spinning a bubble of glass which spread into a circular shape and was cut into small panes, (crown glass). This basic method was improved but continued to be used into the 20th century.

After the fall of the Roman empire, glassmaking in Europe declined rapidly and did not flourish again until the Crusaders brought Byzantine craftsmen from the near east to Venice, starting a Venetian dominance of the art which lasted into the 16th century. Venice gained this dominance by keeping their glass workers virtual, but well treated, prisoners. However some craftsmen managed to escape and spread their secrets to other parts of Europe where glassmaking made considerable progress.

It was not until 1607 that glassmaking, the first American industry, was established in the new world at Jamestown. This start failed, as did many subsequent attempts to establish glassmaking in America. The first successful glass industry was established by German-born Caspar Wistar, in Salem County, New Jersey in the year 1739.

For many years, glass development stood still. The making of glass was essentially the same in 1900 as it was 300 years previously. However, in 1916, glass started moving when Michael J. Owens perfected the worlds first machine for flat drawing window glass. This did more, in a few years, to revolutionize the art of flat glassmaking than anything had done for thousands of years previously. It set the stage for the great achievements we know today.

Perhaps the most important characteristic of glass is how its properties can be controlled and varied. These properties may be classified generally as mechanical, chemical, optical, thermal, electrical and nuclear. By changing the basic composition, product design and manufacturing processes glass can be given a wide variety of predetermined and controlled properties.

Although there are tens of thousands of workable glass compositions they are all derived from six basic types of glass.

1. Soda-lime glass the most common and accounts for nearly 90 per cent of the millions of tons of glass produced in the world each year.

2. Borosilicate glass can withstand sudden temperature changes and is ideal for products such as telescope mirror blanks.

3. Lead glass has a high index of refraction which gives it many optical applications in lenses and prisms.

4. 96% Silica glass has exceptional thermal endurance, chemical resistance excellent electrical characteristics.

5. Fused Silica because of its exceptional radiation resistance and low thermal expansion rate it is in demand for astronomical and space applications.

6. Aluminsilicate glass combines good electrical and chemical properties with outstanding thermal shock resistance. Unlike 96% silica and fused silica, this glass does not require special processing, but is made by traditional glassmaking techniques. It is used for high temperature thermometers, combustion tubes, and stove-top cooking ware.

Plate and window glass producers serve the residential, industrial, and institutional building industries. In recent years, over 50 per cent of the industry's total output has been for automobiles. The two largest producers of flat glass are Pittsburgh Plate Glass Company and Libbey-Owens-Ford Glass Company.

The potential of glass is enormous. Specialists have been shattering huge sheets of glass in a drive to develop larger, stronger sheets of architectural glass. Glass strips resembling lengths of extruded metal channel are being twisted, pressed and smashed to determine their value as support elements in buildings. The enormous promise of glass is what makes these and the countless other tests like them so exciting.

Information Sheet
IS 3-15

BRICK MANUFACTURING

Brick is classified under the clay products industry and is one of the oldest building materials known to man. It is an important industry today. More than 6 billion bricks are made per year for construction purposes. The demand for this product is varied due to its dependence upon the construction industry. The industry tries to compensate for this variance by storing excess material during slack seasons but this is not the ideal situation because it involves added handling, thus more expenses. The low unit cost, availability of raw material, and the expense of transportation tend to distribute the brick industry through the country. Most of these manufacturers are small scale operators.

The raw material (clay) is crushed, ground and cleaned of foreign matter. The pulverized clay is mixed with water to the proper consistency, extruded in bar form and cut to size. These "green" bricks run on a conveyer belt to the drying room for several days of air drying, then are taken to a kiln and fired to a temperature of 1,000°F. for common brick or 2,000°F. for refractory brick.

Competitive conditions among brick makers have led to the increased mechanization of the industry. This change in the type of workers needed has reduced the flexibility of production, layoff and idle machines to a condition where a smaller work force works all year and stores products in the slack season.

Information Sheet
IS 3-16

CEMENT MANUFACTURING

Cement is one of the earliest known bonds used in the construction industry. It was used by the Egyptians in building the great pyramids but the art of making cement became lost through the dark ages. Today cement is one of the mainstays of the construction industry, as it is used in pre-cast shapes, prestressed beams, cinder blocks, slabs, roads, and shell construction.

The basic material used in making cement is a mixture of calcium, aluminum, silicon and iron. The first step in the manufacture of cement is to take the raw materials and break them up into small pieces. The process can continue by two different methods from this point.

The wet process, where the material is ground in a slurry, is superior as the consistency of the material is more readily adaptable for the machine processing. The time involved is longer because the water must be removed. This is then put into a rotary kiln and heated to a temperature of 2700°F.

In the dry process, the raw material is put into a ball mill to pulverize; then put directly into the kiln. The material comes from the kiln in the shape of clinkers and due to the seasonal demand of the industry, is often stored until needed. When they are ready to ship out the cement, the clinkers are run through a pulverizing machine, bagged and shipped out.

The most common type of cement today is portland cement. The basic raw materials used to make portland cement are limestone and clay or shale. The raw materials are crushed, dried, weighed, combined and ground to a fine powder called the raw mix. The raw mix is thoroughly blended and burned in a rotating kiln, which produces very hard clinkers. Then an exact amount of gypsum is added. Finally the whole mixture is ground up again and sifted through screens. The result is portland cement--a gray powder usually packaged in 94 lb. paper bags and available from most building materials dealers.

Concrete is a mixture of sand (fine Aggregate), gravel, or crushed stone (coarse aggregates), water and a material called cement. Concrete has several unusual properties that make it a versatile and widely used building material. For example, it sets or hardens in the presence of water. This property is of great importance in the construction of buildings or parts of structures, such as footings and foundations, built on the earth or in wet locations.

Freshly mixed concrete can be formed into practically any shape. Many materials can be molded only when heated and they require elaborate casting facilities, but concrete can be molded at normal temperatures, which gives it tremendous flexibility.

Since concrete is composed of mineral materials, it is impervious to bacterial attack and the resultant decay. It also resists vermin, termites and rodents. Concrete is made of materials that cannot burn. Portland cement is manufactured at temperatures up to 2,700°F. Aggregates are also incombustible. Thus concrete has a high fire resistance so important in rural areas where fire protection is often inadequate.

The basic ingredients of concrete-portland cement and aggregates--are available almost everywhere at reasonable prices. Hence, concrete is economical in all parts of the country.

These many properties combine to give concrete structures and improvements low initial costs, minimum maintenance requirements and long life.

The concrete made with portland cement, sand, gravel, and water can be mixed on the job, or it can be ordered already mixed. This "ready mixed" concrete is delivered in large mixer trucks.

The proportions of the ingredients in concrete are different for different types of work. One common mixture is what concrete men call the "1-2-3 mix". This means that the mixture includes one part cement, two parts sand, and three parts gravel or stone. The amount of water to be added also varies according to the job to be done. In a critical job, such as a large building, the structural engineer or architect will specify exactly what concrete mix is to be used.

The most common method of making something of concrete is to pour the wet, mixed concrete into wooden forms or metal forms. Then, after the concrete has hardened the forms are taken away.

Large shapes, such as building foundations are poured or cast right in the position where they are to stay (sidewalks, footings for houses, roads). Smaller pieces, such as concrete blocks or concrete trim for buildings are cast in forms in factories and shipped wherever they are needed. When they arrive at the building site, these blocks are laid in place, using mortar to hold them together. Examples of pre-cast concrete are steps, bird baths, concrete pipe, pre-cast walls, etc.

Reinforced concrete is concrete which has been strengthened by iron or steel bars or mesh embedded in it. Roads, dams, buildings and bridges are made stronger by being reinforced.

Pre-stressed concrete is usually prestressed by means of high strength steel wires that are placed in tension and held in this position while the concrete is poured and allowed to set surrounding the wires. The stretched high-strength steel induces compressive stresses in the concrete. Prestressed concrete allows longer unsupported spans and greater loads than ever before. It permits the building of bridges, roofs, floors, and walls with longer spans between supports and greater strength for carrying loads.

LUMBER MANUFACTURING

Lumbering has been traditionally classified as an extractive industry; however, the processing of the logs into many forms of millwork transfers the activity to the manufacturing area.

Modern logging operations are located in the Pacific Northwest as the dominant producer while the Southeastern area is growing in importance mainly because of its favorable growing season and large area.

Current production of the New England, Middle Atlantic and Lake Region states combined account for only 8 per cent of the total lumber production.

The first sawmills were built in Jamestown, Virginia (1625) and in Berwick, Maine (1631) and major lumbering activity centered in this area for two centuries. The industry gradually shifted to the upper Hudson River area followed by central Pennsylvania where 30 large sawmills operated at Williamsport in 1860. The Great Lakes states were predominantly lumber centers until the turn of the century.

The National Lumber Manufacturers Association estimates 2000 billion board feet of standing saw lumber are available in the United States.

Wood is considered by many authorities to be the most important raw material because it is available at relatively low cost, has a great variety of structural, esthetic, insulating and chemical properties. With man's proper management it will be inexhaustable because of its ability to renew itself.

The principal operations in the manufacture of lumber are:

1. The breakdown of the logs into boards or timbers.

2. Cutting the boards or timbers lengthwise in a ripping or edging operation with the ob-

jective of removing wane, improving the grade, or dimensioning the width.

3. Cutting the boards across the grain in a crosscutting or trimming operation for the purpose of removing defects, improving the grade, or dimensioning to length.

Major lumber manufacturing processes include the following: material handling, ripping and cutting, edging and surfacing, and finally kilns for curing.

Materials handling includes conveyors, elevators, lift trucks and tractors, cranes, derricks, hoists, and blowers.

Saws are classified into three categories based upon their general shape and method of drive as circular, band and reciprocating.

The surfacing of two sides and machining of the edges is accomplished by the basic planer with various attachments to expand their range and use.

Air drying is determined by atmospheric conditions which vary in different areas of the country. Kiln drying provides a way of overcoming the limitations imposed by naturally occurring temperature and humidity changes.

The lumber industry is characterized by a large variety of distributing agencies whose major function is to facilitate and expedite the movement of lumber from the manufacturer to the consumer. Some of these distributing agencies are a part of the manufacturing organization, but more frequently they are independent agencies.

INTRODUCTION TO THE DISTRIBUTION INDUSTRIES

Webster's New International Dictionary defines distribution as "the physical conveyance of commodities from producer to consumer". Producers, naturally, are those sources from which the commodities originate.

For our purpose, distribution is the transportation of goods from place to place. The systems of transportation may be broadly classified as land systems, water transportation, and air transportation.

Transportation of commodities occupies a definite and important position in our national economy. Without it, economic activity would be impossible. Every economic activity depends upon some form of transportation for its existence. Industrial plant locations are determined to a great extent upon their problems of moving raw materials and products of manufacture.

One way to observe the importance of transportation is to look at the loading docks of truck, rail, and ship terminals. If any of these means of shipment suddenly stops, the goods clog the terminals and affect customers throughout the nation and the world.

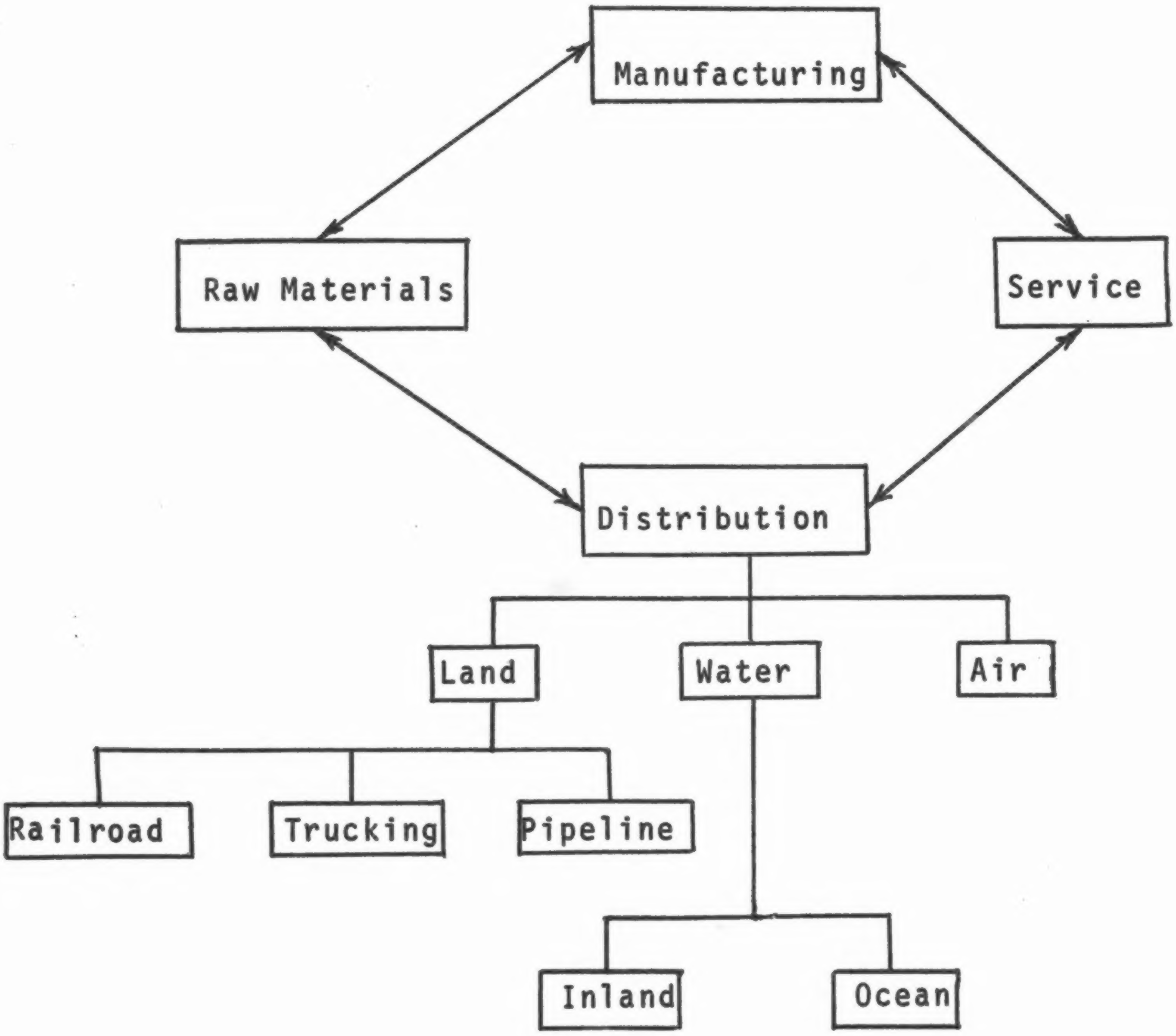
Over the course of the last two centuries, transportation in the United States developed in the following order: the horse-drawn vehicle, water, railroad, pipelines, highway transport, and air transport. The transportation development, as we know it today, involves some of the greatest of man's scientific, technological, and industrial achievements.

In the study of this material, you will have an opportunity to explore the distribution industries and the modes of transportation involved. We will study the effects of distribution on the economy of the nation, state, community, and the individual.

How important are the distribution industries?

The intent of the following chart is to show a horizontal slice of the major industries with emphasis on distribution, and show how the industries are related to each other.

MAJOR INDUSTRIES OF THE UNITED STATES


Manufacturing
Raw Materials
Service
Distribution
Land
Water
Air
Railroad
Trucking
Pipeline
Inland
Ocean

LAND TRANSPORTATION - RAIL, HIGHWAY, AND PIPELINE

Early railroads were mostly used in mines and short distance hauling, usually pulled by animals. As the nation expanded and the need for greater speed over longer distances carrying greater loads increased, steam engines replaced animal power and short lines were combined to eventually reach the far corners of the country.

The effect of railroads on the U. S. has been tremendous. They are responsible to a large extent for the settlement of the country and the development of the country as an industrial nation. Railroads were one of the first modes of transportation available capable of moving large quantities of goods from one place to another.

In our study of railroads as a part of the Distribution Industries, we will study the history of railroads and their effect on our economy. We will also study some of the problems faced by the industry and certain controls placed on them by the government.

For many years the railroads were practically the only means of inland transportation of merchandise shipments. However, with the continual improvements and increase in local and state highways and motor vehicles since the turn of the twentieth century, a substantial amount of merchandise traffic has been diverted from railroads to trucks to become one of our chief distribution industries.

The motor carriers haul on the average about 12 billion tons of freight annually because of its lower transportation charges, flexibility of routes, frequency of service, and convenience. About three-fourths of all freight, including pipeline products, is moved at some point by truck.

In general, freight transportation can be divided into three main types, common carriers, contract truckers, and private carriers. This material will provide you with the opportunity to study the general types, regulations, and nomenclature of highway transportation.

Pipelines, a line of pipe with pumping machinery and apparatus for conveying liquids and other products, will be discussed as part of the great distribution industries.

Pipelines were first used in China about one thousand years ago. The first commercial use of the pipeline in the United States was to transport natural gas through a small lead pipe in 1825.

The pipeline industry as we know it today has taken giant steps forward in both materials and the methods in which it is laid. Pipelines are used for transportation of various liquids and gases under many circumstances, but their predominating use in the United States is for the cross-country transportation of crude oil and refined petroleum products and natural gas. There is a new trend at the present to increase the commodities moved by pipelines, such as powdered coal, wood pulp, and chemicals.

Pipelines involved in interstate movement have the status of common carriers under the Interstate Commerce Act, and thus regulated through this method. Pipelines share with railroads the distinction of being built and operated entirely by private investments.

WATER TRANSPORTATION

Water transport is the only form of commercial or for-hire transportation now in use which is older than the railroads. In fact, water movement was for many years the only type of economical transportation available for ordinary commercial purposes; and the population of the country, therefore, was limited to narrow areas along our seacoasts and the banks of navigable rivers. This was true until the early nineteenth century when the coming of the railroads opened up the vast interior of the country to settlement and economic development.

Domestic water carriers normally operate in coast-wide service along the Atlantic, Pacific, and Gulf coasts; intercoastally through the Panama Canal between the Atlantic and Gulf coasts on the one hand and the Pacific Coast on the other; on the Great Lakes; via the Atlantic and Gulf intracoastal waterways; and along various inland waterways, chiefly the Mississippi River and its tributaries and the New York State Barge Canal.

Water-borne transportation is considered the most economical and also the slowest. It is adapted mainly for large bulky cargo, where speed is not important. In most cases other means of transportation are needed to get the cargo to and from ports. To make shipping profitable the ship needs a cargo load in both directions. This is usually done if possible.

Water-borne commerce on the Great Lakes and their connecting channels is greater than on any other inland waterway. The recent development of the St. Lawrence Seaway now makes it possible for ocean-going vessels to bring cargo directly to the inland ports of the Great Lakes.

Information Sheet
IS 4-4

AIR TRANSPORTATION

The first commercial use of airplanes was for the transportation of mail, which began in 1918. These operations at first were limited to daytime flights, night service being inaugurated in 1925. Passenger service began in the late twenties but in 1932 mail revenues still represented 80 per cent of the total operating revenues of air carriers. As airlines were extended, airports and other aids were provided at public expense, and progress was made in speed and frequency of operation. Passenger transportation gained as a source of revenue for air carriers. In 1946 the relative proportions of total revenue received were 87 per cent from passengers and less than seven per cent from mail.

As regards general cargo, movement by air is subject to certain handicaps which appear, for the present at least, to be inherent in this method of transport. Such problems include the cost of handling cargo between the commercial districts of cities and the airports, which in the case of large cities means an average distance of about eight miles; the necessity for weighing cargo into the plane and its careful stowage in accordance with a prearranged weight schedule worked out for each individual plane and each individual flight; the corresponding necessity for anchoring cargo so it cannot shift its position in the plane; and the high proportion of air shipments which originate at points which are not air terminals and, therefore, have to be further handled by some other means of transportation.

There is still a definite place for air freight in the distribution of products. The outstanding characteristic of air transportation is speed. For long distance, its advantages in this respect are unrivaled. However, these advantages diminish, and in some instances, practically disappear, as the length of the journey shortens. Planes are used primarily for the movement of high priority and/or perishable goods over great distances. Manufacturers have found that they need fewer warehouses and less inventory for small high cost items. An order for an item can be filled out and sent quickly to any part of the country, or in many instances, any part of the world. These orders can be delivered as quickly, if not quicker, than if the company had warehouses located in strategic parts of the country or world.

Planes have almost a monopolistic hold on the movement of machinery and supplies into what would ordinarily be inaccessable areas, such as mines in the mountains and north woods. These areas usually call for planes with a large load carrying capacity and needing only a short runway to take-off and land. Helicopters are coming into increasing use for those reasons. Helicopters are especially helpful in transporting crews to offshore drilling towers.

Perhaps nowhere in our whole industrial and technological complex have we made such significant and far-reaching advances as we have in the field of aerospace. How sophisticated are our problems of today, compared to those at Kitty Hawk in 1903!

Aerospace is a field that can lead us in as many directions as the imagination can pursue. We can approach it from the four areas of manufacturing, raw materials, distribution or service with equal ease. It can incorporate production, power, transportation, electricity-electronics, sociology, economics, politics, geography, research and experimentation, projects, problem solving, mathematics, physics, chemistry, astronomy, meteorology, and international human relations and possibly interworld human relations.

Aerospace is the "youngster" of our power and transportation categories, yet here is an area that has tremendous implications for our future.

Welcome to Aerospace education -- and remember, "The sky is not the limit!"

2

Information Sheet
IS 4-6

PREPARATION FOR LAUNCHING A MODEL ROCKET

Model rocket engines, no matter how small, should be used with caution and respect. These engines should be used only in model rockets which are designed around these engine characteristics.

Construct your model rocket vehicle of lightweight, non-metallic materials such as laminated papers, balsa wood, plastic or fiberglass. Never launch a rocket without a recovery device, such as a streamer or parachute, which will return the model slowly back to Earth after its flight.

Model rocket engines should be ignited by electrical means only. Do not stand near a rocket engine while it is firing. During an actual launching, the individual in control of the firing switch should never stand closer than 15 feet from the rocket, while all other assistants and spectators should stand back at least 25 feet. Actually, a better view of the launch is possible when standing back 50 to 100 feet.

Your rocket should be launched from a guiderow type launcher which will keep the rocket in a vertical flight direction until sufficient stabilizing velocity is reached. Never launch a rocket without a launcher.

Launch your rocket from an unpopulated area, away from houses, airports, or airplanes, highways, and trees. Select a cleared launching site-away from dried grass or other dense foliage. Model rockets generally require a launch and recovery area equal to the square of the expected altitude to be reached by the rocket. In other words, a rocket expected to reach 1000 feet altitude should be launched from the center of an open field measuring about 1000 feet by 1000 feet. Never attempt to launch from a yard or in the street.

Avoid launching in windy or overcast weather, as recovery under these conditions will be difficult if not impossible. A lightweight model rocket which is launched in strong winds will weathercock and travel directly into the wind. Remember that a slight wind on the ground usually indicates much faster winds at higher altitudes. Such a wind will cause your chute to drift and land your rocket a considerable distance from the launcher.

Always give a short countdown before launching. This is to alert spectators and draw everyone's attention to the rocket about to be launched.

Never subject a model rocket engine to temperature greater than 150 degrees F. DO NOT, in any way, tamper with or alter the engine. Never attempt to reload an expended engine case. Never drop an engine or use one that has been damaged. When in doubt, don't take unnecessary chances. Destroy by soaking in water only.

Store model rocket engines in a cool, dry place, away from other combustible materials. DO NOT SMOKE near rocket engines, and above all, keep away from open flames. Never point the nozzle end of the rocket engine toward the face.

Information Sheet
IS 5-1

LAUNDRY SERVICE

This service at first examination may appear to be a "service to people industry", but a closer examination reveals that this process falls into the area of "service of products". This service industry does not manufacture a product, but makes a product usable again. As a support industry to other industries, it is growing in importance due to the use of wiping rags, cleaning cloths, and uniforms.

At the end of World War II, small launderettes mushroomed all over the United States. Generally these were composed of a battery of small home washers, operated strictly as a self-service operation. Then the demands by customers changed to attendance service, thus enabling the housewife to give her bundles directly to an attendant without having to do the washing herself.

Early operations of these plants consisted of washing the family wash load as a unit. The wash was then dried in a gas or electrically powered tumbler, or left as wet wash. Customers soon asked for additional services; consequently, many operators added shirt presses, small flatwork ironers, and other equipment to meet these consumer requests.

The great growth of these plants immediately after World War II brought about the development of branch plants, drive-in stores and activated units. Generally, the branch plant or drive-in store is merely a collecting place, with little work done on the premises. In the activated unit, equipment is set up to handle certain work, while most is sent to a main plant for processing.

DRY CLEANING SERVICE

Dry cleaning is a process of cleaning textile articles with organic solvents, special soaps and detergents, and mild chemical reagents. The solvents are employed in dry cleaning somewhat as water is in laundering. However, these solvents have no effect on textile fibers, dyes, and finishes, or on garment tailoring characteristics.

Solvents from crude oil, which are today used in specially refined forms by more than 80% of all cleaning plants, were first used for dry cleaning purposes in the United States shortly after the introduction of gasoline in 1875. The trouble with the early solvents was the constant threat of fire and the odors that it left in the garments. In the 1950's, various solvents were developed which were known as the "safety solvents". These solvents must reach the unlikely temperature of 140°F. before there is any danger. As a result, explosions in modern plants are unheard of, and fires are not above normal incidence for business properties.

The progress of the industry in the United States was relatively slow until 1939, though dry cleaning by then had long since left the luxury class of personal services. Prices were about $2.50 for a suit or dress, but had fallen to as low as $.29 during the price wars of the 1930's. A sharp rise in business volume followed in the 1940's and continued unabated into 1952, where prices seem to have stabilized at $.80 to $1.25.

Information Sheet
IS 5-3

APPLIANCE AND ELECTRIC MOTOR REPAIR SERVICE

This area has become important to everyone in our gadget age. The home is full of motor driven appliances and other devices that require constant attention. Industry uses thousands of controls and motors in the area of material handling and automation on the assembly line. All of this equipment needs attention at one time or another.

Basically, however, the work of an appliance-motor repairman involves repairing or adjusting appliances ranging from small appliances such as toasters, mixers, vacuum cleaners, etc. to the larger appliances involving more complex control systems such as refrigerators, washer-dryers and dishwashers. A closely related area, the electric motor repair, is also usually involved.

In addition to the use of general hand tools, the service man must be able to use special tools and testing devices (wattmeters, ohmmeters, voltmeters, vacuum and pressure gauges). To become successful in his work, the service man should be competent in the areas of electricity, physics, wiring diagrams, and mathematics. A continuous training program is necessary for him to remain proficient in his area.

The working conditions and wage rates have been slightly above average in industry. Employment opportunities of service technicians should increase as more new appliances become available almost daily.

RADIO AND TV REPAIR SERVICE

The radio and television repair industry is similar to many other service industries in that the size and organization varies greatly. There are many such repair shops that do only radio and television repair while others are a part of a large radio, television and appliance sales organization. However, the purpose is the same in either setup and that is to repair or replace the part that is not functioning.

Television receivers require by far the most attention at this time, especially with growing numbers of colored television sets. However, other equipment need also be considered, namely, phonographs, tape recorders, intercommunication equipment, public address systems, etc.

Most of the work in this industry is of a diagnostic nature, requiring the necessary repairs and/or replacements and adjustments. Such work requires that the technician be able to use the basic hand tools of the trade, such as soldering equipment, long nosed pliers, wrenches, screwdrivers, etc. The correct use of these is necessary to avoid damage to the delicate parts. In addition, training in the electronics field is required if the person is to become proficient in this area. This training is often supplied by employers or trade associations. Vocational and technical schools also give the same type of training.

Employment of service technicians is expected to increase as a result of the rapid growth of the electronic industry. However, technological developments will increase employment opportunities only for those television and radio service technicians who have a theoretical as well as practical knowledge of the electronics field and the skills to use the latest test equipment.

TOOL AND DIE REPAIR SERVICE

Tool and die makers are highly-skilled, creative workers whose products--tools, dies, and special guiding and holding devices--are the basis for mass production in metalworking industries. They not only construct or produce these devices, but are often times required to repair, service and maintain them.

Tool and die making involves the construction of special jigs and fixtures which are devices that are needed to hold metal or other material while it is being shaved, stamped, or drilled. It also involves the making and use of gauges and other measuring devices that are used in manufacturing precision parts.

In order to stamp out or forge a piece of metal, a die must be used. These dies are constructed by tool and die makers. Tool and die makers also make molds used in diecasting and in molding plastics.

In comparison with most other machining workers, tool and die makers have a broader knowledge of machining operations, shop practices, mathematics, and blue print reading, and can work to closer tolerances, thus doing more precise handwork. Tool and die making involves the use of almost every type of machine tool and precision-measuring instrument.

The increasingly complex, modern machinery and metalworking equipment in use today demands that tool and die makers have a high degree of technical training in the applied sciences and mathematics along with a great degree of skill in using equipment and tools.

SMALL ENGINE SERVICE

There are many individual owners or possibly partnership organizations that limit their service to the repair of small engines. The service varies from minor adjustments to complete engine overhaul.

Small gasoline engines have come into widespread use, replacing muscle power for many tasks and thereby helping us to enjoy life. The uses of small engines are many and varied. Some typical uses are on boats, motor scooters, motorcycles, power for tools and equipment, and as power to drive generators for producing power.

Most small engines work under extremely dusty conditions and require frequent adjustments and periodic complete overhauls. Trouble may develop in the carburetion and ignition systems, as well as various mechanical troubles. The service man must use a troubleshooting procedure to find various problems and correct them.

The following labor charges are representative of those found in a shop specializing in the repair of small engines:

Overhaul engine	$12.00
Overhaul carburetor	2.75
Tune and adjust engine	3.75
Sharpen and adjust mower	4.25

The following parts are frequently used in servicing a small engine:

Piston	$ 3.75
Piston and rod assembly	5.35
Piston rings	3.15
Valve	1.35
Gasket Set	1.85
Carburetor repair kit	.65
New carburetor	6.85
Ignition replacement parts	1.65

REMEMBER - These labor charges are used only as examples of charges for labor on small engines. These charges will vary from time to time in various parts of the U. S.

SAFETY REPAIR SERVICE INSTRUCTIONS FOR SMALL ENGINES

The two main types of small engines are 2 cycle and 4 cycle, both of which are in common use.

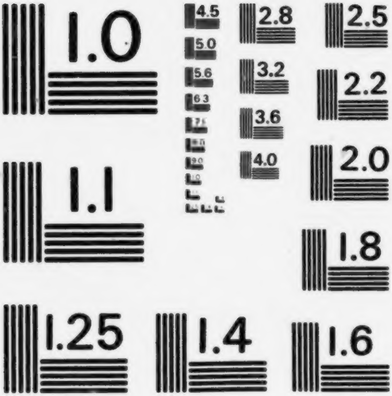
In some applications, the engine may require frequent servicing and adjustments; many minor services may be done at home. Carelessness when servicing engines may cause damage to the engine or to the service man. The following are safety precautions that must be followed when working with engines and related equipment.

1. Provide efficient ventilation. Exhaust gases contain carbon monoxide which is a deadly poison.
2. Do not fill gas tank while engine is running. Gasoline spilled on a hot engine may cause explosion and serious injury.
3. Keep engine clean. If cooling system becomes clogged, serious damage may result.
4. Be sure nobody is behind you when starting the engine with a rope starter.
5. Always disconnect spark plug wire from spark plug before moving the blade on a rotary lawn mower while cleaning.
6. Keep hands and feet clear of mower blade or other rotating machinery.
7. Check on fuel and oil requirement. Use of the wrong fuel may cause damage to the engine.

There may be other precautions, but common sense must be used when working with moving machinery.

Before attempting to disassemble an engine, the parts manual or operating and maintenance instructions should be studied.

3755



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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SMALL ENGINE CARBURETORS

A carburetor is a device for mixing gasoline and air, in the correct proportions, so that the resulting vapor, when compressed in the engine cylinder will explode and force the piston down. The carburetor must spray or atomize the fuel and thoroughly mix these particles with air. It must also be designed so that it delivers the mixture to the engine in correct proportions under all operating conditions from idling to full load.

The original carburetors were relatively crude in design and could operate only because the gasoline available at that time was easily vaporized. Some of the earlier types of carburetors were designed so that the air drawn in by the engine would first pass over the surface of some gasoline. In that way, enough gasoline vapor was carried on to the engine as a combustible mixture. Another type used a wick, the lower end of which was submerged in gasoline, while air passed over the exposed end and then into the engine cylinder. A third type was known as a mixing valve.

In the mixing valve type, air is drawn in through the valve which is opened by the suction of the engine. The air passing the opening to the gasoline supply draws fuel with it and the mixing of air and fuel is drawn into the cylinder. The amount of fuel is controlled by a needle valve.

The operation of the mixing valve type carburetors was erratic. The proportion of fuel to air was seriously affected by the height of the fuel supply level above the mixing valve, the quality of the fuel and the speed of the engine. For example, the rate of air flow through the carburetor, between idling speed and full load changes in a ratio of more than 100 to 1.

To overcome the difficulty in the variation of fuel flow due to the change in height of the fuel supply level above the mixing valve, Mayback designed a carburetor which utilized a float which maintained the level of the fuel within the carburetor at substantially the same level. In this design, fuel is supplied to a float chamber which is part of the carburetor. The float rises with the level of the fuel, and when it reaches the desired height, a needle valve, mounted on the float, shuts off the fuel supply. As fuel is used or consumed, the float drops and the needle valve opens, permitting fuel to flow into the chamber until the desired level is again established.

Requirements of Carburetion

As previously pointed out, the purpose of a carburetor is to prepare and supply a mixture of fuel vapor and air, in proper proportions for efficient combustion. There are many factors which make this difficult. First of all, when an internal combustion engine is started, it is cold, so a fuel mixture containing a larger portion of fuel is required. When the engine reaches operating temperatures, such a mixture is too "rich" and is not efficient. In addition, the engine will not operate satisfactorily, particularly at idling speeds.

Another difficulty that must be overcome by a carburetor is that when an engine is idling or operating at slow speeds, a richer mixture is required than when operating at medium speeds and power. When maximum power or acceleration is required, the amount of fuel in relation to air is again increased.

Variations in types and characteristics of fuel also are complications to be overcome in effective carburetion. Gasoline does not always burn at the same temperature, as it is a blend of various parts or fractions of crude petroleum. As a result, some of these fractions contained in present day commercial gasoline will boil (vaporize) at 100° F. and others at temperatures ranging up to 400° F.

Proportions of Gasoline and Air

For normal operating conditions, the best economy is obtained by a mixture of one part by weight of gasoline to between 16 to 17 parts of air. For quick acceleration and maximum power, a somewhat richer mixture is needed--about one part of gasoline to 12 to 13 parts of air. Also for idling, a somewhat richer mixture is required than for normal operation. Similarly, when starting a cold engine, an extremely rich mixture is needed.

Principles of Operation

Both air and gasoline are drawn through the carburetor and into the engine cylinder by the suction created by the piston moving downward in the engine cylinder. In other words, as the piston moves down in the cylinder, a partial vacuum is created in the cylinder and combustion chamber. It is the difference between the pressure within the cylinder and the atmospheric pressure which causes both air and fuel to flow into the cylinder from the carburetor.

The principle or method whereby the moving air draws the fuel from the jet or fuel supply is important and of interest. When atmospheric air flows through a pipe into a chamber, the under-pressure or vacuum increases from zero at the entrance and reaches a maximum at the entrance to the chamber. So, if a small tube connected with a supply of fuel is brought through the wall of the air tube, the open end of the gasoline will be subjected to under-pressure or partial vacuum and gasoline will be forced from the gasoline tube. The rate at which gasoline is discharged depends on the pressure difference between the partial vacuum and the atmospheric pressure. The area of the outlet of the gasoline tube is of course, also a factor. An example of the method, whereby moving air draws fuel from a reservoir, is found in the familiar hand spray guns.

A high suction can readily be produced by reducing the area at one point in the air tube. Such a restriction is known as a venturi, and the gasoline tube or jet is placed at that point. Basically a venturi tube consists of two tapering tubes with their small ends joined. When a fluid, (in this case air) is passed through a venturi tube, its static pressure is greatly reduced at the narrowest portion of the venturi and then increases again after passing the restricted area.

Information Sheet
IS 5-10

TROUBLESHOOTING SMALL ENGINES

The following chart lists troubles commonly experienced with small gas engines. Possible causes of the trouble are given, along with the probable remedy.

This chart is only a guide to use in locating a source of trouble. For information on step-by-step tuneup or repair procedures, consult the repair manuals supplied by the manufacturer of the engine being repaired.

Engine Fails to Start or Starts With Difficulty

No fuel in tank - Fill tank with fuel.

Obstructed fuel line - To confirm, pour a small amount of gas in cylinder through spark plug hole, replace plug; if engine starts, trouble is in fuel line or carburetor. If necessary, remove and clean carburetor.

Gas cap vent obstructed - Open vent in gas cap.

Water in fuel - Drain tank, clean carburetor and fuel line, dry spark plug points, and refill tank with fuel.

Engine over-choked - Close fuel shutoff and pull starter until engine starts. Re-open fuel shutoff for normal operation.

Improper carburetor adjustment - Adjust carburetor.

Loose or defective wiring - Check magneto wiring for shorts or grounds.

Faulty magneto - Check timing, point gap, and, if necessary, overhaul magneto.

Spark plug fouled - Clean and regap spark plug.

Spark plug porcelain cracked - Replace plug.

Poor compression - Overhaul engine.

Engine Knocks

Carbon in combustion chamber - Remove cylinder head and clean carbon from head and piston.

Loose or worn connecting rod - Replace connecting rod.

Loose flywheel - Check flywheel key and keyway; replace part if necessary. Tighten flywheel nut to proper torque.

Worn cylinder - Replace cylinder.

Improper magneto timing - Time magneto.

Engine Misses Under Load

Spark plug fouled - Clean and regap plug.

Spark plug porcelain cracked - Replace plug.

Improper spark plug gap - Regap plug.

Pitted magneto points - Clean and dress breaker points. Replace if badly pitted.

Magneto arm sluggish - Clean and lubricate breaker point arm.

Faulty condenser - Check condenser on tester, replace if necessary.

Improper carburetor adjustment - Adjust carburetor.

Improper valve clearance - Adjust valve clearance.

Weak valve springs - Replace valve springs.

Reed fouled or sluggish (2 cycle) - Clean or replace reed.

Crankcase seals leak - Replace worn seals.

Engine Lacks Power

Choke partially closed - Open choke.

Improper carburetor adjustment - Adjust carburetor.

Magneto improperly timed - Time magneto.

Worn piston or rings - Replace piston or rings.

Lack of lubrication - Fill crankcase to proper level.

Air cleaner fouled - Clean air cleaner.

Valves leaking - Grind valves.

Reed fouled or sluggish - Clean or replace reed.

Improper amount of oil in fuel - Drain tank, fill with correct mixture.

Crankcase seals leaking - Replace worn seals.

Engine Overheats

Engine improperly timed - Time engine.

Carburetor improperly adjusted - Adjust carburetor.

Air flow obstructed -Remove any obstruction from fins.

Excessive load on engine - Check operation of associated equipment and reduce excessive load.

Carbon in combustion chamber - Remove head and clean carbon from piston and head.

Lack of lubrication - Fill crankcase to proper level.

Improper amount of oil in fuel mixture - Drain tank, fill with correct mixture.

Engine Surges or Runs Unevenly

Fuel tank cap vent hole clogged - Open vent hole.

Governor parts sticking or binding - Clean and repair governor parts.

Engine Vibrates Excessively

Engine not securely mounted - Tighten mounting bolts.

Bent crankshaft - Replace crankshaft.

Poor Compression

Loose spark plug - Tighten spark plug.

Loose head or blown gasket - Tighten head or replace gasket.

Piston rings carboned, worn or broken - Remove, clean, or replace.

Burned piston - Replace piston.

Worn cylinder - Rebore and fit new piston.

Poor lubrication - Use proper fuel mixture.

Worn or damaged piston rings - Replace piston and rings.

Defective crankshaft oil seals - Replace seals.

Information Sheet
IS 5-12

AUTOMOTIVE AND FARM EQUIPMENT SERVICE

An automotive service industry may range in size from a small one-man shop to a large automotive sales and service industry staffed by many. Many of the small one-man service shops will work on all types of vehicles from a small car to a large truck. A larger shop may have many separate facilities including, for example, a department specializing in automotive transmissions.

Another service industry, primarily concerned with servicing of automotive equipment, is the service station industry. Many times these service stations will be in conjunction with a repair shop; however, the primary service of this industry is to supply fuel, add and change oil, and lubricate the vehicle.

The farm equipment service industry is a relatively new industry in comparison to other industries. Although the automobile industry was nearly twenty years old, less than 1,000 tractors were in use on farms in 1910. Agricultural economists estimate that the nation's farmers now spend an average of approximately 20 per cent of net farm income on farm equipment purchases. A typical farm of 350 acres on which corn is raised now uses nearly $25,000 worth of machinery and about one half of the farm expenses go for machine maintenance and replacements.

With the large investment which the farmer makes in equipment, it is imperative that he get the most from the machinery which he buys. The farm equipment service industry is concerned with repair and maintenance of many types of equipment from repair of small garden tractors to the repair of large farm equipment such as tractors and combines. With the large investment of the farmer in his equipment and his necessity for keeping it in good repair in order to get a good return from this investment, coupled with the wide range of equipment with which the farm equipment service industry works, will of necessity entrench this industry in our economy.

RENTAL SERVICE NEED AND STATUS

There Is A Need For The Rental Equipment Industry. There are a few rental stores which specialize in the unusual, such as the store near Hollywood which rents props and other equipment to the film studios. But generally the type of equipment that the public rents is for their convenience, pleasure, and recreation.

The most wanted pieces of household equipment are floor polishers and rug cleaners. Power tools and lawn mowers are the tops in the hardware line. During the income tax reporting season, operators report a heavy demand for adding machines and typewriters. Spring and fall, rotary tillers, lawn combers, sod dusters, spray equipment, and other lawn and garden accessories are in heavy demand. In apartment areas, wallpaper steamers and papering equipment are in heavy demand. Extra beds, baby cribs and highchairs are items needed when company or relatives with children come to visit. The list of rentables is endless.

What Makes The Rental Industry Tick? The rental equipment industry is still regarded as an infant industry. A survey taken by the American Rental Association reveals that 48 per cent of their members have been in business five years or less; 39 per cent have been in business from six to ten years while 3 per cent have been in business for 20 years or more. Only 10 per cent of the members have been operating rental stores for eleven to fifteen years.

Many rental people entered the business through the building or mechanical trades and find their experience in the maintenance and repair of tools and other equipment is invaluable. Many stores are the "Mom and Pop" variety, where husband and wife work side by side in the store. Many operators have been alarmed because of the entry of department stores and chain stores into the rental business. Competition has forced increased advertising and sales promotion, resulting in the increase of rental volume for all.

Interested Manufacturers The story of the industry that does the renting is equally interesting and perhaps less known. It is the story of hardworking individuals who have moved in as middlemen between the customers who want to rent on one hand and the manufacturers on the other hand.

More manufacturers every year are cultivating these middlemen. They send their sales representatives to call, flood the rental operator with mail, advertise in the Rental Equipment Register (a trade publication), and they pack the annual trade show of the American Rental Association.

The shows illustrate this growing interest. At the first convention in 1956, a grand total of five manufacturers exhibited. In the 1963 show, 161 suppliers toted their wares to Salt Lake City to tempt rental operators. They bought more than $750,000 worth of goods on the spot.

Conceivably, manufacturers might shun rental operators on the ground that they compete with their regular dealers. Exhibitors at Salt Lake City thought differently.

Advantages For manufacturers, renting turns out to be a plus market. A rental operator buys merchandise for customers who might never buy themselves, and the operator is a repeat buyer. He has to be to keep rental stock in top working order. For the same reason, he buys good merchandise. A leading maker of hedge trimmers, generators, and hobby-tools has stated that the most important reason for selling to the rental market is that the rental operators are his advertising agency. It has been the greatest thing that has ever happened to our business.

Leaders in the rental business say that the rental industry "literally built the market for camping trailers." Other leaders in this business have said that it is a great market for many reasons, but the problem is how to reach it.

The vacation market rental equipment store includes such items as: camping trailers, camp stoves, tents, sleeping bags, cots, lanterns, car top carriers, binoculars, sleds, toboggans, ice skates, skis, and other related equipment. This market lies largely untapped. However, in the last few years the outdoor camping and recreational market has begun to catch on with the American family. National and state parks and other public use areas have been enjoying record-breaking attendance. Many families, not sure they would enjoy camping, have been reluctant to purchase the necessary equipment so they rent. Renting vacation needs allows many families to enjoy lower-cost vacations.

Although not universally stocked, certain types of sporting goods equipment can be found in some areas. For instance, water sports equipment can be rented from many rental stores located within the snow belt.

The contractor's rental equipment industry was born in the growing California area. The rental yards in this area started the contractor's tools market. This inventory includes: compressors, generators, welders, jacks, cement tools, trucks, tractors, pumps, and scaffolding.

Contractors have found the rental store or yard to have some advantage. The contractor rents the equipment for the time he uses it and does not have to have his money tied up in a wide variety of construction machinery. Rentals, in this case, are charged against the cost of the job. He does not have to pay for licenses or taxes on the equipment, nor does he have to account for depreciation costs.

Each year the rental volume of contractor tools grows steadily. Although acceptable in some regions, there is still a selling job to be done in other areas.

The Do-It-Yourself-Rental Market of electrical tools was the original inventory of the rental equipment store. During and since World War II, when tools and equipment were hard to come by, many rental men first started with these tools. Today's inventory includes: portable saws, power drills, plumbing tools, yard and garden tools, ladders, auto tools, floor care equipment, masonry tools, painting and decorating equipment, and augers.

The millions of new homes, explosive growth of population, plus desire for more leisure have contributed to the success of the tool rental market. Manufacturers of small tools have found the rental equipment industry to be a proving ground for their products. Performances, durability, and the quality are important features to be considered. Low maintenance is essential to a successful rental operation.

The party equipment market is another growing area of rental equipment. Equipment in this area includes: tables, chairs, silver, patio equipment, P.A. systems, coat racks, tape recorders, crystals, linens, TV sets, and projectors.

Hostesses have found that renting their party needs will save them money. Society leaders have found that renting party equipment is convenient for them, even though economy is not a factor. Some stores will rent mink stoles for those who really want to achieve a certain status! More and more Americans are giving parties, banquets, family reunions, anniversary celebrations and afternoon teas than ever before. The rental store is a convenient place to visit for party-giving equipment.

The Invalid Needs Rental Market is popularly known as "soft-goods" or non-tool equipment. Their inventory usually includes the following: crutches, wheel chairs, hospital beds, patient lifts, bed tables, walkers, and bed screens.

Some stores make a specialty of renting inhalation equipment and other specialized medical equipment. These operators work directly with clinics, hospitals, doctors, physical therapists and others. However, the general rental equipment store will stock the normal convalescent and home nursing equipment.

PHYSICAL PLANT MAINTENANCE AND SERVICE

An efficient industrial production must have effective maintenance to the plant, and the equipment in it.

Good management will not wait for the building to decay or machines to stop working, but will anticipate needs and have preventive maintenance performed. However, these needs cannot always be taken care of before problems arise. There is no exact timetable on the effects of weather and the wear on the building resulting from vibration and general use. Machines and equipment are also subject to wear and tear from use.

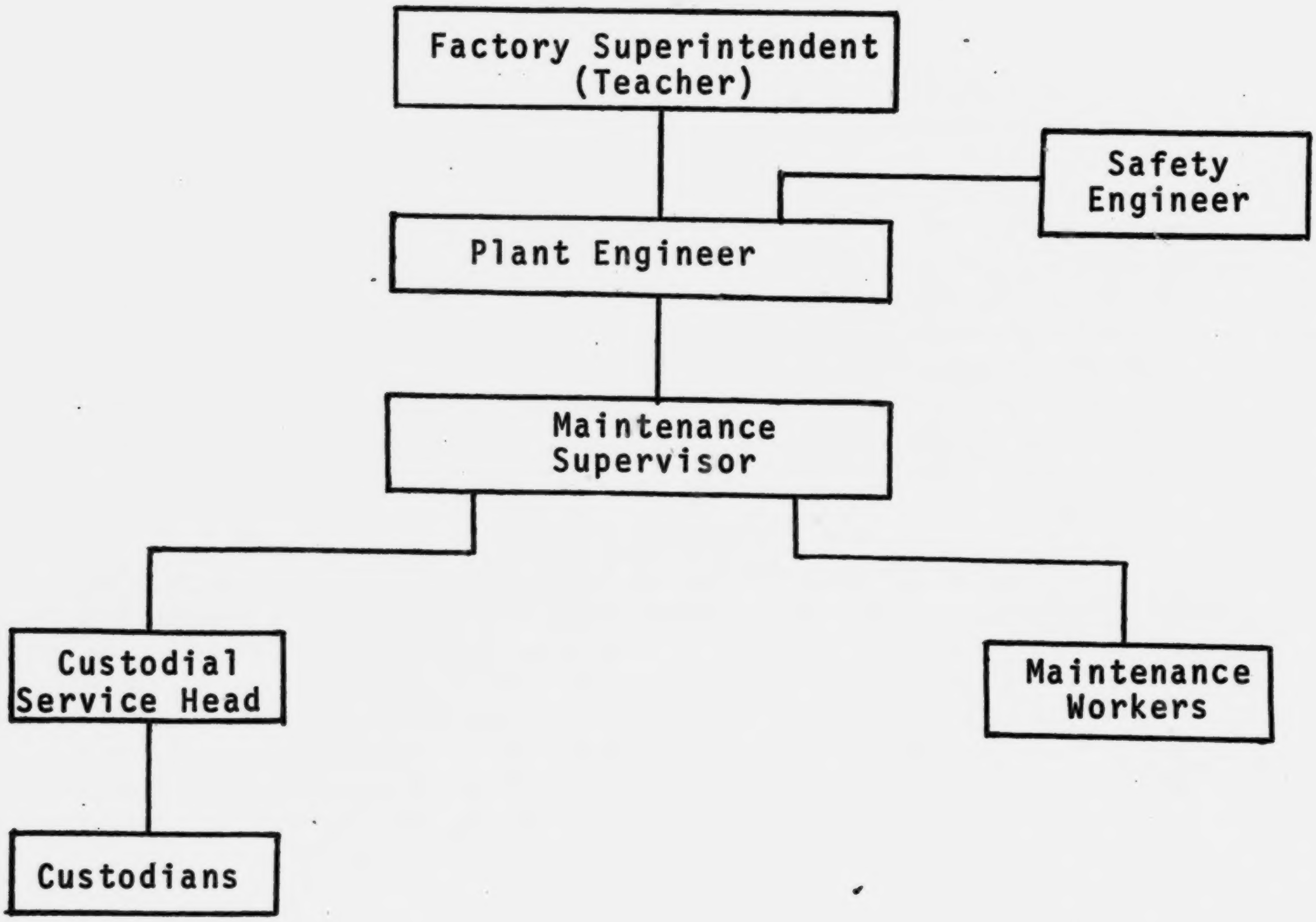
Even within a single company the definition of maintenance varies. Sometimes it includes repairs and upkeep of all facilities and equipment as well as janitorial services. New trends find some of the maintenance performed by factory teams from the equipment manufacturer or by an outside contracted service agent. In other cases the equipment may have been rented, with the maintenance being performed by the renter.

A leading industrial manager of safety says, "additional efforts must be made to bolster the plant maintenance man's morale, because he is often made to feel like the low man on the totem pole. It is essential that management recognize the maintenance man's importance to production, and it is also essential that every maintenance man realize that his effort is appreciated. Let him know that he is an important part of the team and that his opportunity to advance is limited only by his own ability. Then reward him in accordance with his performance".

Below you see a physical plant organizational chart which our class will attempt to develop. Study it and ask the teacher about any points which you do not understand.

IS 5-15

ORGANIZATIONAL CHART FOR PLANT MAINTENANCE


Factory Superintendent (Teacher)
Safety Engineer
Plant Engineer
Maintenance Supervisor
Custodial Service Head
Maintenance Workers
Custodians

JOBS AND DUTIES:

Factory Superintendent - The teacher will assume this. He will be responsible for all activity in the maintenance division.

Plant Engineer - In charge of plant layout, plant maintenance and safety engineer. The plant engineer reports to the factory superintendent.

Maintenance Supervisor - In charge of custodial services and maintenance workers. Reports to the plant engineer.

Maintenance Supervisor - In charge of custodial services and maintenance workers. Reports to the plant engineer.

Custodial Service Head - In charge of the custodians and reports to maintenance supervisor.

Custodians - Duties are to keep the physical plant clean. They report to the custodial service head.

Maintenance Workers - Each maintenance worker will be assigned to at least one machine. The theme will be preventative maintenance (performing maintenance in anticipation of need). He will clean the machine daily. He will also lubricate it as specified by policies set down by the plant engineer and his staff. Reports to maintenance supervisor.

Safety Engineer - Will be required to keep a constant watch for safety hazards. It will also be his job to design ways to correct these hazards (if any), and improve on existing procedures.

NOTE: We will run an incentive plan involving everyone in regard to safety improvements. Anyone suggesting an idea for improvement will receive some kind of extra credit in proportion to the importance of the safety improvements.

The safety engineer reports to the plant engineer.

Information Sheet
IS 5-16

CONSTRUCTION SERVICE INDUSTRIES

Some industries are somewhat difficult to classify as being strictly service or manufacturing. Some of the industries that fit into this category are: (a) building construction and repair, (b) electrical wiring and rewiring, (c) plumbing installation and repair, (d) heating and air conditioning, (e) earth moving, and (f) utilities.

The building construction industry, comprised of skilled and unskilled workers in many trades, employs a considerable portion of the labor force. In the U.S., 10 per cent of the working population is involved directly or indirectly in building construction. Building construction in the U.S. is made up of the following professional and business interests:

1. The contractor co-ordinates the work of assembling materials into a structure.

2. The labor force increases production by using new techniques and equipment and more efficient use of existing equipment.

3. The manufacturer who develops better material and better distribution methods.

4. The engineer who has made possible modern structural development.

5. The architect, with artistic and technical knowledge, has introduced new ideas that are changing the future of building.

The modern building contractor is organized for more efficient production of the work than in the past. Some building contractors have become what is known as brokers, taking complete responsibility for a project but turning over all the work to subcontractors.

Building construction and repair may involve carpenters, plumbers and electricians. The building contractor will contract to build or repair a building and then he may make a contract with a plumbing industry and an electrical industry to do the plumbing and wiring, if there is any to be done. The main contractor, whether it be to build or repair, will do the carpentry and any concrete work that may be needed. In some cases a house construction contractor may have plumbers and electricians as part of his crew so that he will not need to sub-contract to another firm. Furthermore, the electrical or plumbing industry may have a contract directly with the owner to do a particular job. Another service industry involved in building construction is what may be called heating and air-conditioning. Although this industry is primarily concerned with the installation of heating and air-conditioning systems, they do some repair work .

Earth moving industries vary greatly in size and are usually concerned with the construction of something new. They also vary as to whether they might be called service or manufacturing industries as the same industry that constructs ten miles of new road may also repair 100 miles of road somewhere else. Also, there are many small earth moving organizations that dig ditches or holes to repair sewer, gas and water lines and many other things. The equipment used can handle 40 to 50 yards of earth at one time.

Information Sheet
IS 5-17

UTILITY SERVICE INDUSTRIES

Utilities such as gas, electricity, water, and telephone are herein classed as service industries since they do provide a service and the service deals with a product in the broad sense. Electric utilities provide electricity to homes, factories and other businesses and are usually quite large in terms of financial organization and the number of customers each individual industry serves. Gas service industries are also quite large and will have many miles of pipeline, some reaching into the thousands of miles. Many times one company will provide both gas and electricity to a given area. Many of the electric companies are publicly owned and operated while others are non-profit co-operative organizations. However, the majority are profit-making corporations.

Telephone companies are generally quite large, although some are small and serve only a small area. They may be owned and operated by a profit-making corporation or a non-profit making co-operative. Although telephone companies are classed as utilities and do provide a service, it is difficult to class that service as a product. However, the service provided is such that there must be maintenance done on the equipment that aids in supplying the service. The telephone industries require many types of industrial workers such as engineers and electricians.

Water service has water as its product and this requires miles of pipeline, pumping stations, and meters among other things. All of this equipment must be installed and maintained, and this requires industrial work such as plumbing, meter maintenance and the planning and laying out of pipeline systems. Most water service industries are publicly owned and operated, usually by a city or community.

MASS PRODUCTION ASSEMBLY

The assembly of a commercially-made product such as a scale model can well serve the need of each student to understand the internal organization of industry without having all the skills necessary to manufacture a product similar to industry. Later you will study the raw materials, manufacturing, distribution and service industries which will bring out many details of industrial organization that will not be included at the present time. Since the product we will assemble has been manufactured commercially, we will only concern ourselves with the assembly processes and management organization for this product.

The assembly process is just the end result of a mass production industry. The business and management necessary to set up and assemble model cars are just as important. Usually the first function of industry would be to set up the corporation. A corporation is organized by the group interested in making a product. They meet to choose a board of directors and develop the rules and regulations, called a charter, that the corporation will live by. These directors choose the officers responsible for the daily conduct of affairs and they fix their salaries.

People invest in the corporation and receive stock certificates for each set unit of money invested. Anyone holding 51 per cent of the stock can vote with the most influence. However, it is possible to have an influential voice with less than 51 per cent of the stock by giving proxy votes, which means that a stock holder with less votes will agree with policies set forth by the major stock holder.

Management is the directing of business. The central idea of management is to make every action or decision to help achieve a carefully chosen goal.

The management positions and responsibilities for the assembly are as follows:

General Manager - Chief executive who will direct all the activity of the project. All staff and line function will fall within the manager's authority and responsibility.

Quality Control Manager - Staff job to maintain quality of the product in line with established policy and standards set by class and teacher acting as management.

Materials Control Manager - Responsible for control of materials as to quality, quantity, timing, and costs.

Production Control Manager - Responsible for order preparation, routing, scheduling, dispatching and follow up operations.

Materials, Tools and/or Equipment Needed:

Styrene cement
Styrene paint (basic colors)
Air brush or paint brushes (artist's)
Hypodermic needles to apply cement
Clear lacquer
Benches and stools
Drying lights
Cement solvent
Masking tape
Paint solvent

Your instructor will furnish you with a detailed plan of the assembly of the product which you will make. You will want to make sure that you take time to carefully read all of the instructions.

If you mass assemble the product in a line mass production you will need to know your specific job well. The instructor, together with you and the other members of your class, will decide on what particular job you will have. Remember, the kind of job which you perform on each unit will determine the quality of the product you and the class will have in the end. Good luck!

DETERMINING THE AMOUNT OF MOISTURE IN LUMBER

Lumber with a moisture content which is less than six per cent may be considered thoroughly kiln dried. A moisture content of 10 to 15 per cent indicates thoroughly air dried lumber. You can learn how this is determined by doing the following activity.

Materials, Tools and/or Equipment Needed:

Four randomly selected boards, at least five feet long, 6 inches wide, and 3/4 inch thick.

An accurate, sensitive scale or an apothecary's balance.

An electric oven or means for heating the samples of wood.

Procedure:

1. To test for moisture content, select four boards from different parts of a stack. Cut the boards at a point at least two feet from the end and then saw off a piece one inch long, the full width of the board, from one of these fresh ends. Do not cut test pieces less than one foot from the ends of any board for testing moisture content because the ends may be affected by end drying.
2. Remove all splinters and loose particles from the outer surface of these sections and label each piece for future identification. Weigh the sections separately on an apothecary's balance or sensitive scale, and record the weights of each.

3. Place the sections in an oven heated to 212° F. or lay them on a hot steam pipe. Weigh them at intervals of 10 to 15 minutes and record the weight. When they reach a constant weight, subtract this constant weight from the first weight and you will have the weight of the water expelled from the wood.

4. Divide the weight of the water by the dry weight of the wood and multiply by 100 which will give the moisture content of the wood expressed in a percentage. In order to establish reliability of the test, you should take at least four sections from four separate boards at random from the pile.

Summary Statement:

When the average temperature and humidity of any region is known, or as may be determined from the Weather Bureau records, it is possible to determine what the moisture content of the wood should be for the conditions.

STRENGTH TESTING OF WOOD

The first comprehensive series of timber tests made by the U.S. Government and Forestry Division were made and published about 1884. Over 400 species of American woods were tested for strength and density. A new series of timber tests were made at Purdue, Indiana, California, Oregon, and other universities in 1903. Later tests were made at the Universities of Colorado and Idaho.

Methods of preserving and fire-proofing wood were investigated a long time ago by railroads, telegraph and mining companies. The government began such tests about 1898. About 1901, research was taken over by the Forest Service. The present Forest Products Laboratory at Madison, Wisconsin is the outcome of these several beginnings of lumber and timber research.

Lumber and timber research have developed numerous tests throughout the years, some of which are: Impact tests; Vibration and fatigue tests; Treating tests; Tests on frozen wood; and, compression and tensile strength tests.

The following procedure was designed to compare the amount of bend and the amount of force particular wood samples will withstand before the wood structure fails.

Materials, Tools and/or Equipment Needed:

Guided bend test apparatus (similar to Fig. 1)
Hydraulic jack, Scales, Rule, Radius block,
Wood samples 3/4 x 3/4 x 20", Recording sheet.

NOTE: All wood samples must be of the same dimensions and must be free of knots and irregularities. The wood should be of straight grain.

Procedure:

1. Place wood test strip in testing device. Be sure wood strip is centered. See Fig. 1.

2. Apply pressure to the strip (using hydraulic jack) only until the top of the strip is even with the zero mark on the rule.

3. Adjust pointer on scales to zero position.

4. Apply a slow, even pressure to the strip with the jack.

5. Carefully read and record amount of bend and pounds of pressure at exact time of failure.

6. Remove test strip and set up as in step 1.

Wood samples of wavy grain and containing knots may be used to demonstrate the effects of such wood when placed under stress.

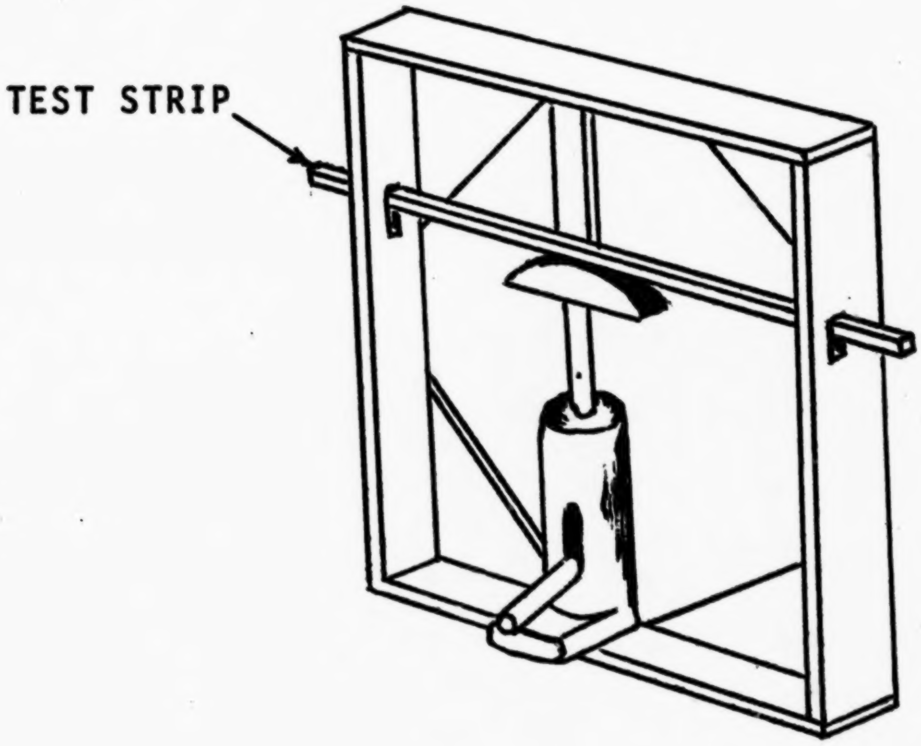


Fig. 1

Type of Wood	DRY WOOD										WET WOOD									
	Amt. of Bend					Amt. of Pressure					Amt. of Bend					Amt. of Pressure				
	1	2	3	4	Ave.	1	2	3	4	Ave.	1	2	3	4	Ave.	1	2	3	4	Ave.
Oak																				
Pine																				
Cedar																				

Fig. 2

Job Sheet
JS 2-3

NAIL SPLITTING OF WOOD

Nail-splitting tendencies of hardwoods are of interest because large volumes of both high-grade and low-grade hardwoods are normally nailed in manufacture. The weakening effect of splits is often greatly overestimated. It is best to avoid or at least minimize splits, because they are unsightly, they tend to increase in size with moisture changes, and they create an unfavorable impression. Splitting can be avoided by boring holes in high-quality products or by using blunt-pointed or smaller nails. Heavy, strong woods split more readily during nailing than do relatively light, weak woods, but they have much greater withdrawal resistance. By using a smaller nail for the heavy woods, however, it is possible to reduce the wood's tendencies to split and still retain a withdrawal resistance. The different woods vary widely in their splitting tendencies when nailed under identical conditions.

In any given test sample, nail splitting is affected by many different factors, including the kind of wood used, the moisture content, the specific gravity, the thickness, the size of the nails, the form of the nail point, the distance that they are positioned from an end or edge of the piece, the method of driving, and so on.

The purpose of this test is to determine the nail-splitting tendencies of the hardwoods used in your shop. The sample pieces used in the test should be of about the same moisture content.

Materials, Tools and/or Equipment Needed:

A sample piece of each of the hardwoods in the shop. The samples are to be 4 in. wide (across the grain), 6 in. long and 3/4 in. thick. The samples are to be surfaced on both sides. Fig. 2

Three 8 d. box nails per sample used.

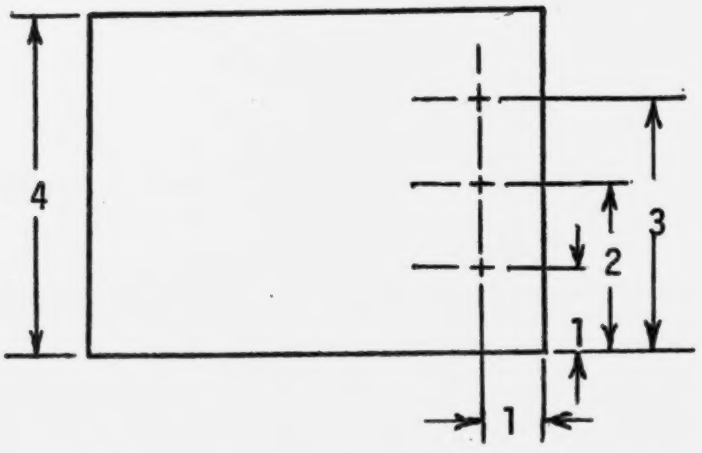
Claw hammer, try square, steel rule, awl, and a scribe.

Piece of scrap lumber to place under the samples when driving the nails.

The nails are to be driven through the samples into the scrap on the back with a claw hammer. As the nails are driven into the samples, notice if any cracking or separation of the wood grain occurs. (Drive the nails as straight as possible.) As the cracks occur in the samples, record them on the chart as shown on the following page. These splits are to be rated as to their degree of split. The rating shall be as follows: 1 for barely noticeable, 2 for intermediate, and 3 for complete. Each of the three nails driven into each sample is given a number 1, 2, 3 or a zero if no split occurs. When all three nails are driven and the numbers have been totaled up and placed in the column to the right, (Fig. 1) then you can give the wood its place in the list of nail splitting tendencies of hardwoods. The higher the total, the greater is the wood's tendency to split.

WOODS	NO SPLIT	BARELY NOTICEABLE	INTER-MEDIATE	COM-PLETE	TOTAL

Fig. 1.



Sample Block

Fig. 2.

Job Sheet
JS 2-4

MAKING WOOD PULP

Centuries ago paper was made by hand. Papermakers mixed macerated (softened) linen rags with warm water in a vat, stirred this slurry to a proper thickness and worked a crude screen mold back and forth, up and down, until a sheet of paper was formed. The process was something like panning for gold. The wet sheets then were squeezed between felt pads on a press and placed on racks to dry.

Today huge machines, some more than a block long, churn away 24 hours a day, six and seven days a week, forming rolls of paper and paperboard at rates up to a half mile a minute to meet our demands for paper products. There are literally hundreds of these paper machines in operation.

Much of the hand-made paper used has come from France, Italy, and Spain. Paper with special required characteristics is still made by the hand process.

References:

American Paper Institute, "The Story of Pulp and Paper".

Materials, Tools, and/or Equipment Needed:

Wood chips, 2 baby food jars, 2 large fruit cans, stirring stick, masher, high rag content paper, nitric acid, sodium hydroxide, laundry bleach, and burlap.

Procedure:

1. The masher is cut from a piece of wood 3/4x 3/4x10.
2. The stirring stick may be a 1/4" dowel, 6" long.

3. Cut soft pine into chips - 3/4" to 1" in length. (may be obtained from scrap wood)

4. Place chips in jar.

5. Add nitric acid to cover wood chips. (CAUTION: USE EXTREME CARE WHEN WORKING WITH ACID AND STRONG SOLUTIONS. SERIOUS BURNING WILL RESULT WITH SKIN CONTACT.) For emergencies, keep a box of bicarbonate of soda (baking soda) handy.

6. Let chips stand over night.

7. Add sodium hydroxide to neutralize.

8. When wood chips are soft, use masher to break chips into fibers. (Do not splash contents!)

9. Continue to stir and mash until fibers reach a "mushy" stage. NOTE: If rag content paper is desired, add small scraps of high rag content paper and repeat step 6.

10. Place pulp in large fruit can, add water and stir until fibers go into solution.

11. Place burlap over another large fruit can.

12. Strain pulp through burlap, catching water in fruit can.

13. Repeat steps 8, 9, and 10 two times each. This will remove the salt.

14. Place pulp in jar, add bleach and stir until pulp is white.

15. Place pulp in fruit can, add water and strain twice as in steps 8, 9, and 10 above.

16. Store wet pulp in jar until ready to make paper. Tinted paper can be made by adding vegetable dye to the pulp and water mixture.

Job Sheet
JS 2-5

MAKING PAPER FROM WOOD PULP

Materials, Tools and/or Equipment Needed:

Wood pulp, mold, fine meshed wire screen, large pan, felt pads, egg beater, press boards, water, clamps, newspapers, electric iron, size (laundry starch)

Procedure:

1. Spread newspaper on bench top.
2. Fill large pan with water, add pulp and laundry starch. 9 parts H_2O to 1 part pulp.
3. Beat with beater until pulp is in solution.
4. Prepare the papermaking mold. See Fig. 1.
5. Hold forming rack firmly on the wire and dip sideways into the pulp mixture.
6. Bring up a level sheet of pulp.
7. Clean off excess pulp outside forming rack. Lift out wire on which the pulp has formed.
8. Dry the wire and wet sheet of pulp between two pieces of felt.
9. Place felts between two press boards.
10. Invert the press boards.
11. Carefully remove wire from matted pulp. NOTE: Use care to see that matted pulp does not crack or break. This will weaken paper.
12. Replace felt pad and press board.

13. Clamp assembly to press out excess water.
14. Iron over felt with warm iron to dry paper.
15. When dry, trim paper to size with scissors.

Summary Statement:

One tablespoon of instant starch in two cups of water will provide what commercial papermakers call "size".

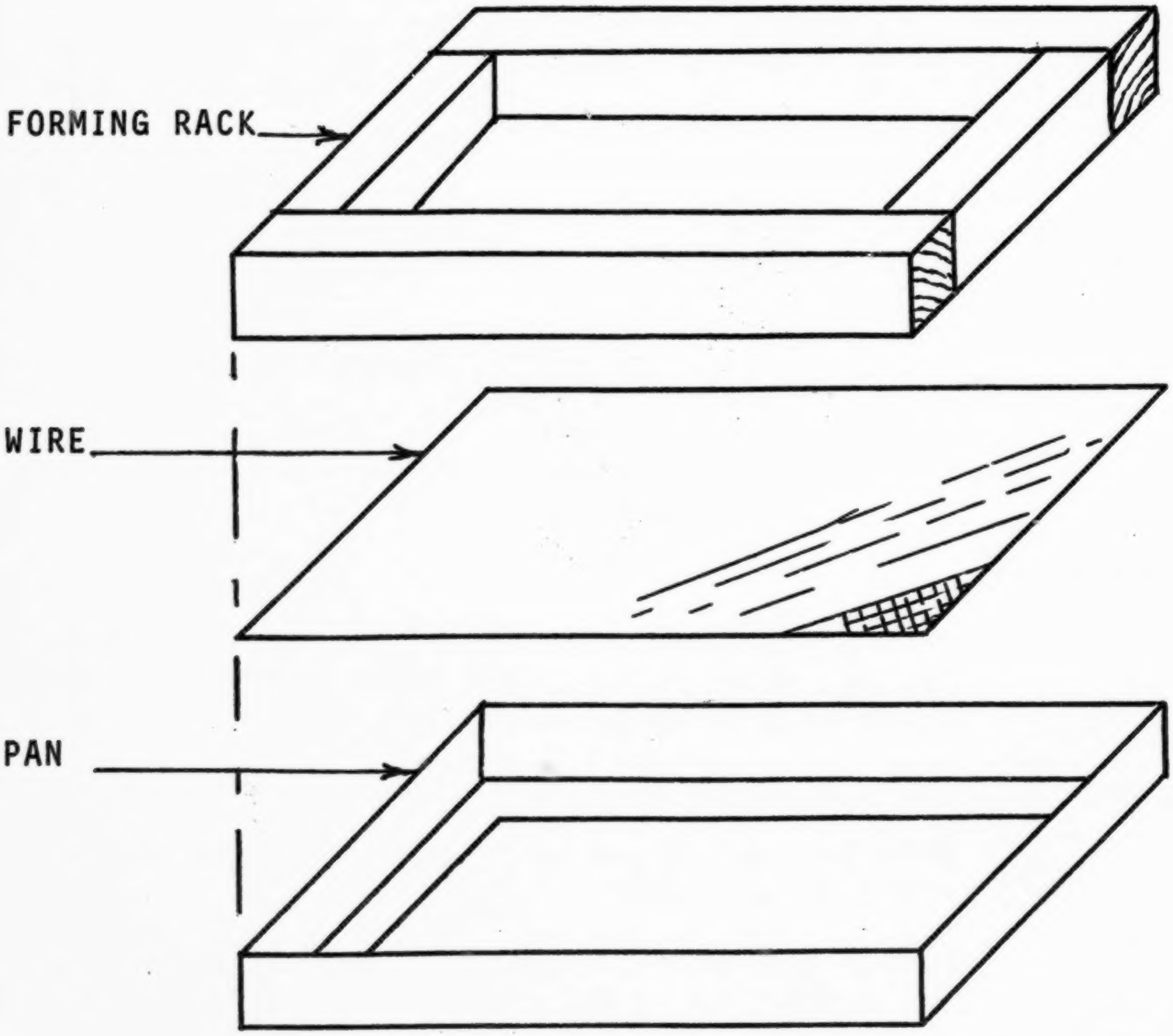


Fig. 1.

Job Sheet
JS 2-6

CHEMICAL COAGULATING

Latex, after collection, is taken to a central station. Foreign matter, such as bark, is removed by pouring the latex through a sieve. The latex varies from 30 to 45 per cent rubber content and is diluted to a uniform consistency of 20 per cent. Addition of a chemical (weak acid) solution causes the latex to coagulate.

Chemical coagulating is beneficial for many other industrial processes. This activity is to show what takes place when a salt, acid, alkali, or heat is applied to a solution with many small particles held in suspension. This activity is designed to use materials with which you are familiar and also to show that this action is not always desirable.

The materials selected for this activity are to illustrate what could take place when a brush is cleaned in the wrong cleaning solvent.

Materials, Tools and/or Equipment Needed:

Lacquer base finish (wood kote), mineral spirits, 2 baby food jars, sieve, stirring stick

Procedure:

1. Fill containers one-half full with the following materials: one with lacquer, the other with mineral spirits.

2. Pour the mineral spirits into the lacquer.

3. Stir mixture together, observing the thickening as you stir.

4. Screen off the thickened mass and determine by comparing jars how much suspended material you gathered by this process.

PRODUCTION OF LEAD FISH SINKERS

Students should first become familiar with the tools and equipment needed for the project before they start on the project.

Materials, Tools and/or Equipment Needed:

Lead - can usually be obtained from old wheel weights, free at service stations

Wire - either copper or stainless steel denture wire

Forge and tongs

Sinker mold (See drawing of a commercial sinker mold - Fig. 1)

Long nose pliers

Leggings and gloves, goggles

Scale for weighing sinkers and heating device for melting lead.

Major steps in procedure for making sinkers utilizing a commercial sinker mold (See Fig. 1):

1. Manufacture wire loops for sinkers.
2. Melt lead
3. Place wires in sinker mold
4. Pour lead in mold
5. Remove sinkers from mold and cool
6. Press off the excess lead on the sinkers
7. Weigh and package sinkers for distribution
8. Distribute sinkers - sales.

To mass produce the lead sinkers you may be assigned any one of the following responsible jobs. Be familiar with as many of them as you can so that you may take over the job of a person who may be absent. As in industry, it is to your advantage to know how to perform more than one task - this is one way of "moving up" into management.

1. Melting operation -
    a. Preheat lead weights to burn off oil
    b. Place weights in crucible
    c. After lead is melted, remove steel clips with tongs from the molten lead
2. Assembly -
    a. Place wire loops in sinker mold
3. Pouring operation -
    a. Pour lead into sinker mold
4. Cooling operation -
    a. One person empty mold when lead is hardened in mold
    b. One person cool sinkers in water and remove
5. Wire cutting operation -
    a. Cut wire to 1 to 2 inch lengths depending on size of sinker
6. Wire forming operation -
    a. Form wire to desired shape - (Fig. 2.)
7. Classification -
    a. Weigh sinker and separate by ounce
8. Shipping -
    a. Each student will sell sinkers (make sure to price cheaper than the store sold sinkers)

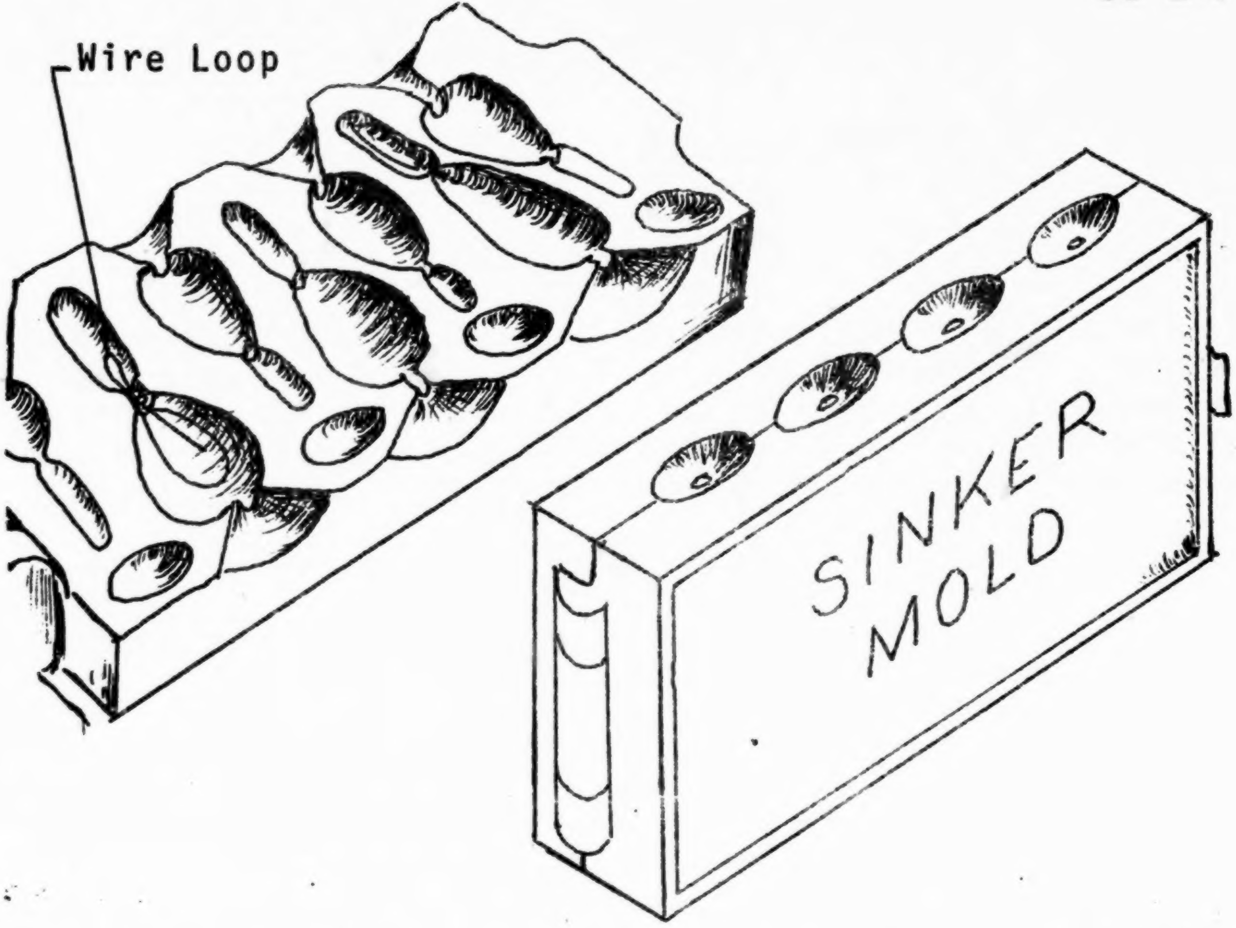


Fig. 1-Illustrates a commercial sinker mold open with one loop laid in the mold cavity. This particular mold may be used by pouring into both sides of the mold, thus making 2 or more sizes of sinkers.

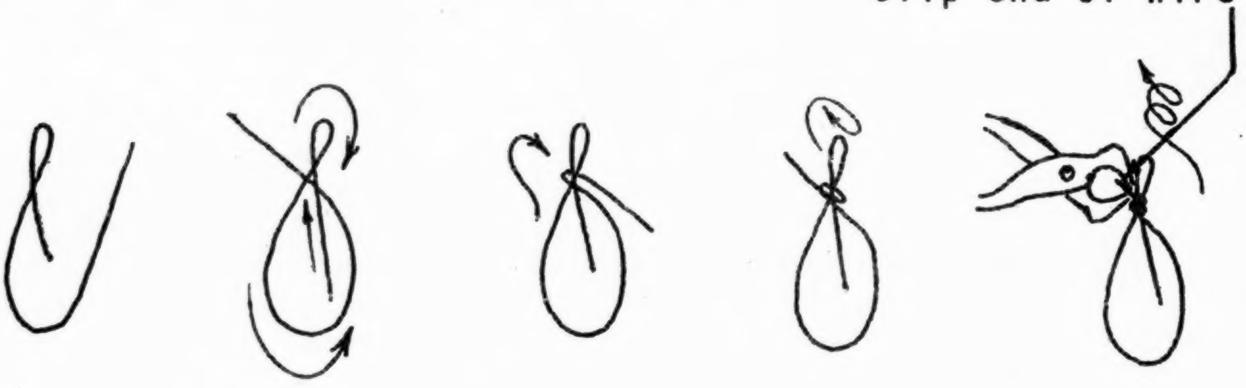


Fig. 2-Illustrates a step-by-step method of making the wire loops which are to be placed in the sinker mold prior to pouring lead. Loops of varying sizes will have to be manufactured, depending on the size of the lead sinker.

Job Sheet
JS 2-8

OBTAINING AND TESTING SOILS

Testing Soils for Lawn or Gardens

Every lawn or garden needs certain plant-food elements such as nitrogen, phosphorus, and potassium. By testing the soil we can find out how much of each of these essential elements is in the soil. We can then determine what must be added to get maximum yield.

Equipment Needed for Taking Soil Samples:

1. A small pail or pan, for mixing the composite soil sample

2. A trowel and milliliter measuring glass.

3. Half-pound paper sacks for holding the samples (one for each sample).

Number of Samples to be Taken and Where:

1. Take three samples in lawn or garden (for comparison).

2. In areas of the lawn or garden that form a triangle.

Get Samples Ready for Testing:

1. Before they can be tested, soil samples must be fine enough to pass through an ordinary fly screen and must be thoroughly dry. The samples can be set in a tray or box to keep them together and the tops of the sacks left open so they can dry out naturally. Do not dry on stove or radiator.

2. As soon as the soil is dry enough, crush it and run it through a fly screen. A rolling pin or a flat hard surface may be used to crush the lumps. Save 100 milliliters of the screened soil and return it to the sack.

Measuring 100 milliliters of sifted soil for each sack puts the same amount of soil in each sack, and all the samples will then dry at about the same rate. After screening, the soil should be left to dry for at least 15 days before testing.

Materials and Equipment Needed for Testing Soils:

A bottle of testing solution

A set of vials with corks (one for each sample) and a rack for holding them

A 2-1/2 gram soil-measuring spoon for measuring the testing solution

A color chart or set of color standards for reading the test

Sudbury Popular Garden Soil Test Kit - Complete directions of tests for nitrogen, phosphorus, potash and soil acidity. Includes equipment and solutions for 50 tests. F13 Model H Popular Garden Model -- $7.95. Available from: Nasco, Fort Atkinson, Wisconsin and Nasco-West, Modesto, California.

Procedure:

1. Number the vial to correspond to the sample it is to hold.
2. Add 4 milliliters of testing solution to each vial.
3. Put 2-1/2 grams of soil from each sample into proper vial.
4. Put stoppers in vials, shake thoroughly, and let vials stand 10 minutes, or longer, if not clear.
5. Read the test and record results.

EXTRACTING SALT FROM WATER

The process of removing salt from water by evaporation can be shown by the following procedure.

Materials, Tools and/or Equipment Needed:

Any flat pan which may be heated

Sample of sea water or salt water. If sea water is not available, make a saturated solution of salt water by adding table salt to water until the salt will no longer dissolve

A source of heat

Procedure:

1. Pour a small amount of the solution in a pan (enough to just cover the bottom).
2. Allow to set on bench overnight or speed evaporation by applying low heat to the bottom of the pan.
3. When water has completely evaporated, the residue will be salt and a few other chemicals which were in the water.
4. If no salt appears, repeat steps 1, 2, 3 until enough evaporation has taken place for salt to appear on the bottom of the pan.

Summary:

You have just used one industrial method of extracting or separating a usable material from a non-usable material. Can you suggest other ways in which salt may be obtained?

MAKING A ROPE

The products made from fibers of vegetable plants, animals, and man-made synthetics are very important to man. He uses a large quantity of rope which may be made from any of these fibers. The rope which you will make is to be made from binder twine. The material consists of fibers of hemp. In this activity, you will become aware of and understand how fibers, when twisted together, will serve the purpose of man. If you follow the procedure outlined, you should be rewarded with a rope of high quality and one which will serve you in many ways.

Materials, Tools and/or Equipment Needed:

A rope twister (Item A in diagram)
A twine holder (Item B in diagram)
Binder twine (6 times the length of rope which you want to make)
A student helper

Procedure:

1. Decide on length of rope you want and cut a length of binder twine 6 times this length.

2. Place the twine holder, Item B, in a vise.

3. Tie one end of the twine on hook number 1 on the rope twister.

4. Holding the rope twister, walk away from the twine holder the approximate length which you want to make the rope. Have your student helper grasp the loose end of the binder twine and carry it to the twine holder at the vise.

5. Have him place the first strand around the twine holder at point X bringing the twine around the back of the holder to point Z and back to the rope twister hooking the twine over hook number 3.

6. Holding twine fairly taunt, have your helper carry it back and place over point Z and bring it up over the back to the rope twister and hook the twine on hook number 2.

7. Have helper take twine back to holder and place over point Y again and back around the back of the holder and over the first strand at point X and back to hook number 1 and tie it to the hook.

Note the diagram and you will see the arrows on the lines pointing in the direction in which the strands of twine must be placed on the holder and the hooks of the rope twister.

8. Have your helper keep the double strands from twisting into the other double strands as you hold the rope twister in both hands, twisting the strands until you have 3 single tightly twisted double strands. The 3 double strands must be kept separated from each other as you twist the strands. Keep turning the rope twister until each strand begins to almost knot up as you turn and twist the strands with the rope twister.

9. Maintain your position and have your helper hold on to the rope twister while you advance to the twine holder, remove the 3 double strands carefully from the holder and twist the 3 double strands in the direction in which they naturally will want to twist when held lightly for a second.

10. Twist the 3 double strands together by hand while your helper holds the twister. Be sure and keep all three double strands pulled tightly as you twist them. Twist the strands as tightly as possible and then let go of your end.

11. Advance to your helper and remove the ends of the 3 double strands from the 3 hooks of the rope twister. The ends may be tied in a knot first using two double strands and then tying one of the remaining double strands to one of the other strands, or dress the end of the rope by wrapping it tightly with a stout nylon or cotton string.

NOTE: This rope will be approximately 3/8 to 1/2 in diameter. If a thicker and stronger rope is desired, you will have to lace over the hooks in the same fashion as you did in steps 1 through 7 but repeat steps 1 through 7 again remembering not to tie the twine at step 7 until completing the steps 1 through 7 again. The amount of twine you would need for this size of rope will be approximately 12 times the length of rope desired, as you will have four strands on each of the 3 hooks instead of 2 strands each.

If a ring is desired on the end of the rope, place a ring in back of the twine holder with a steeple (see Fig. 2) and thread the twine through the ring as you follow steps 1 through 7 carefully.

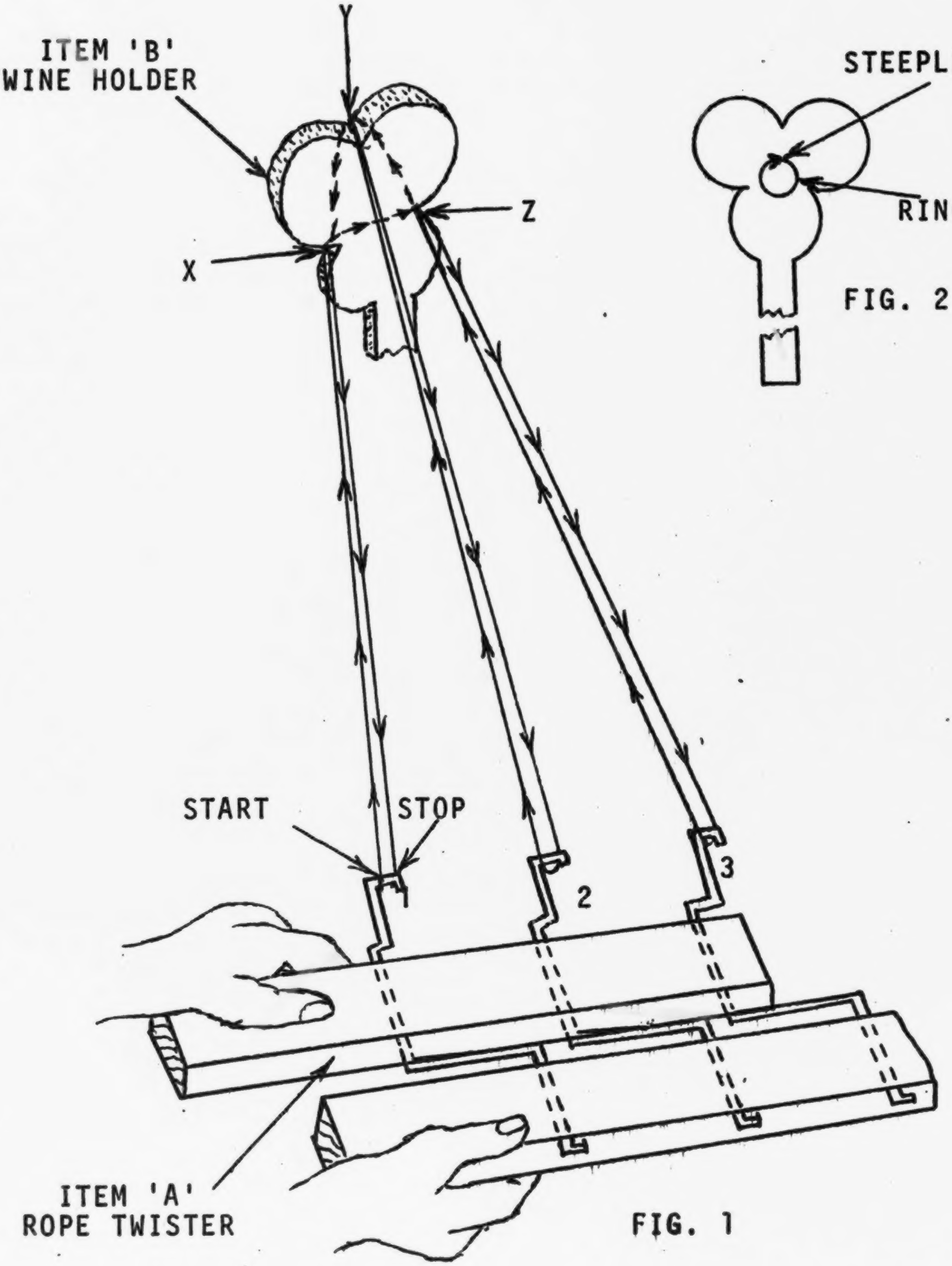

Y
ITEM 'B'
TWINE HOLDER
Z
X
START
STOP
1
2
3
ITEM 'A'
ROPE TWISTER

FIG. 1

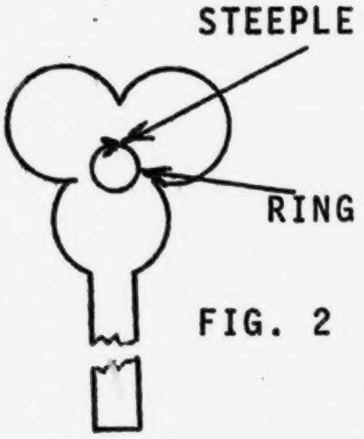

STEEPLE
RING

FIG. 2

Job Sheet
JS 3-2

SYNTHETIC MATERIALS

A Plastic Project

This activity deals with the making of a pair of tongs from acrylic plastic. This plastic is easily formed when heated and is said to have a "memory" because when reheated, it will tend to go back to its original shape.

Materials, Tools and/or Equipment Needed:

- 1 pc. 3/16" x 1" x 18" acrylic plastic
- Buffing equipment
- Heat source
- Sand paper
- File
- Cotton gloves
- Grooved block
- Plastic bending jig

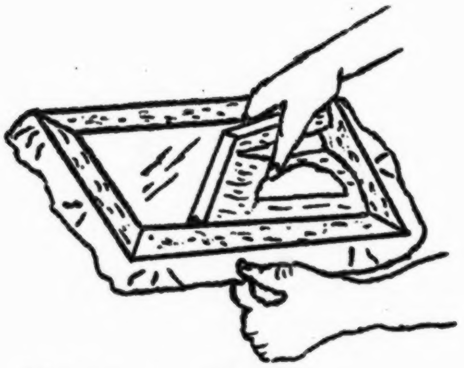
Procedure:

1. Lay out acrylic plastic and smooth edges with file, sand paper and have instructor check.
2. Buff edges of plastic.
3. Heat metal block for melting grooves in plastic ends, melt notches and trim smooth as needed.
4. Smooth remaining edges of plastic.
5. Heat oven to 375° - 390°. When it is heated, place the plastic strip in oven for 4-5 minutes.
6. Remove plastic from oven (with gloves) and place inside form provided by instructor.
7. Clamp form into position and let cool.
8. Remove tongs from form and give finishing touches.

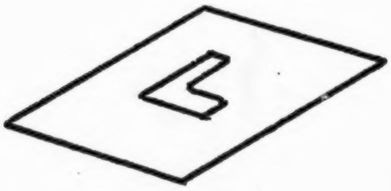
BROWN PAPER METHOD OF SILK SCREEN PRINTING

Procedure:

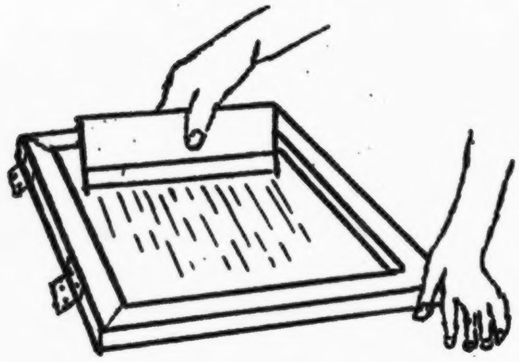
1. Make a miniature frame out of cardboard approximately 4" x 4". Sides are 1/2" wide.
2. Stretch frame with silk screen (or suitable mesh). Staple and tape screen to frame.
3. Trace a suitable monogram on brown (butcher) paper.
4. Using a razor blade (or knife), cut along all lines of monogram to be printed. Do not remove any paper which you have cut yet.
5. Place frame directly over monogram and brown paper.
6. Pour ink directly on the screen.
7. Using a cardboard squeegee, pull the ink over screen, adhering the brown paper to screen.
8. Turn frame over and remove that part of monogram from screen to be printed.
9. Place frame on material where monogram is to be printed.
10. Pour ink on screen and pull across the screen with the squeegee.
11. Remove frame from printed material. Allow print to dry.
12. Repeat process if more monogram prints are desired.



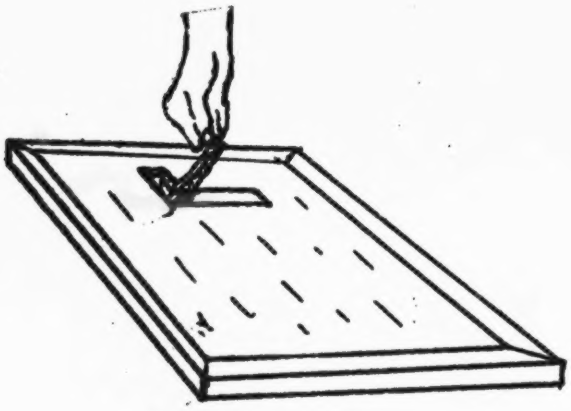
Steps 1 and 2



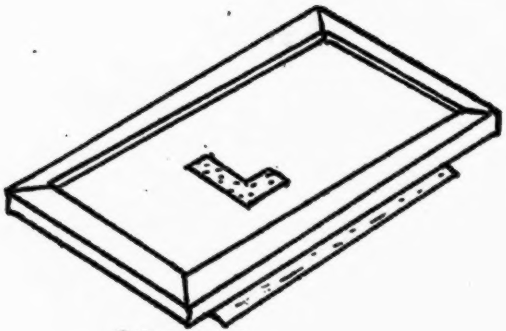
Steps 3 and 4



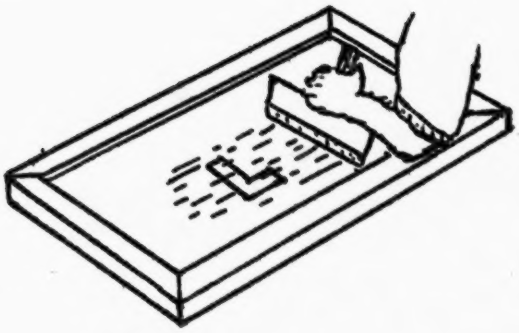
Steps 5, 6, and 7



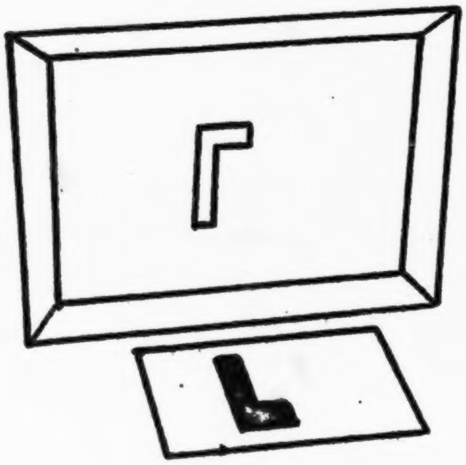
Step 8



Step 9



Step 10



Step 11

JS 3-5

ASSEMBLING A LEATHER PRODUCT

Leather is a most versatile material. It can be used for shoes, belts, purses, upholstery and many other things. The following activity is a very simple one which will give you the experience of assembling a project made of this very versatile material - leather.

References:

Instructions accompanying the purchased leather kit.

Booklet #6, Leather Facts, IM-41.

Materials, Tools and/or Equipment Needed:

Rubber cement for cementing leather
Embossed billfold kits (boys or girls) (From Tandy Leather Company, Kit #P-399 Men's or Kit #397 ladies' Embossed billfold kit)

Procedure:

Remove the instructions from the kit and follow them step by step. The kit contains all of the materials necessary to make the billfold with the exception of a small amount of rubber cement which your instructor will furnish.

WORKING WITH GLASS

Materials, Tools, and/or Equipment Needed: (Cutting Sheet Glass)

Piece of ordinary window glass
Grease pencil
Straightedge
Glass cutter
Heavy gloves

Procedure for Cutting Glass Sheets:

1. Put on heavy gloves.
2. Lay the glass on a smooth flat surface which has been covered with a pad of newspapers.
3. Measure the glass and mark it with a grease pencil.
4. Lay a straightedge across the glass. The straightedge should be just far enough from the location of the cut that the cutter can be moved along the line.
5. Hold the glass and straightedge securely in place with the left hand.
6. Start at the back side, pull the cutter along the straightedge toward the body to produce a continuous scored line in the surface of the glass. This should be done with a single stroke of the cutter. Apply a steady pressure to the cutter with the right hand. Rescoring with the glass cutter will dull the blade.
7. Align the scored line with the edge of the table.
8. Hold the glass down securely with the left hand.

9. Grasp the overhanging glass with the right hand and apply a firm, sharp downward pressure. This will cause the glass to break along the scored line.

Materials, Tools and/or Equipment Needed: (Drilling Glass)

Aluminum, copper or brass tubing of the same outside diameter as the desired hole.
An abrasive (valve grinding compound is excellent)
No. 120 silicon.
Drill press
Clay or putty
Small paint brush

Procedure for Drilling Holes in Glass:

1. Slot one end of the tube, with a hack saw, about 1/16" deep to make it easier to keep the abrasive cutting.

2. Insert the tube in the chuck of the drill press which is set for its slowest speed.

3. Place a soft wallboard or newspaper pad under the glass.

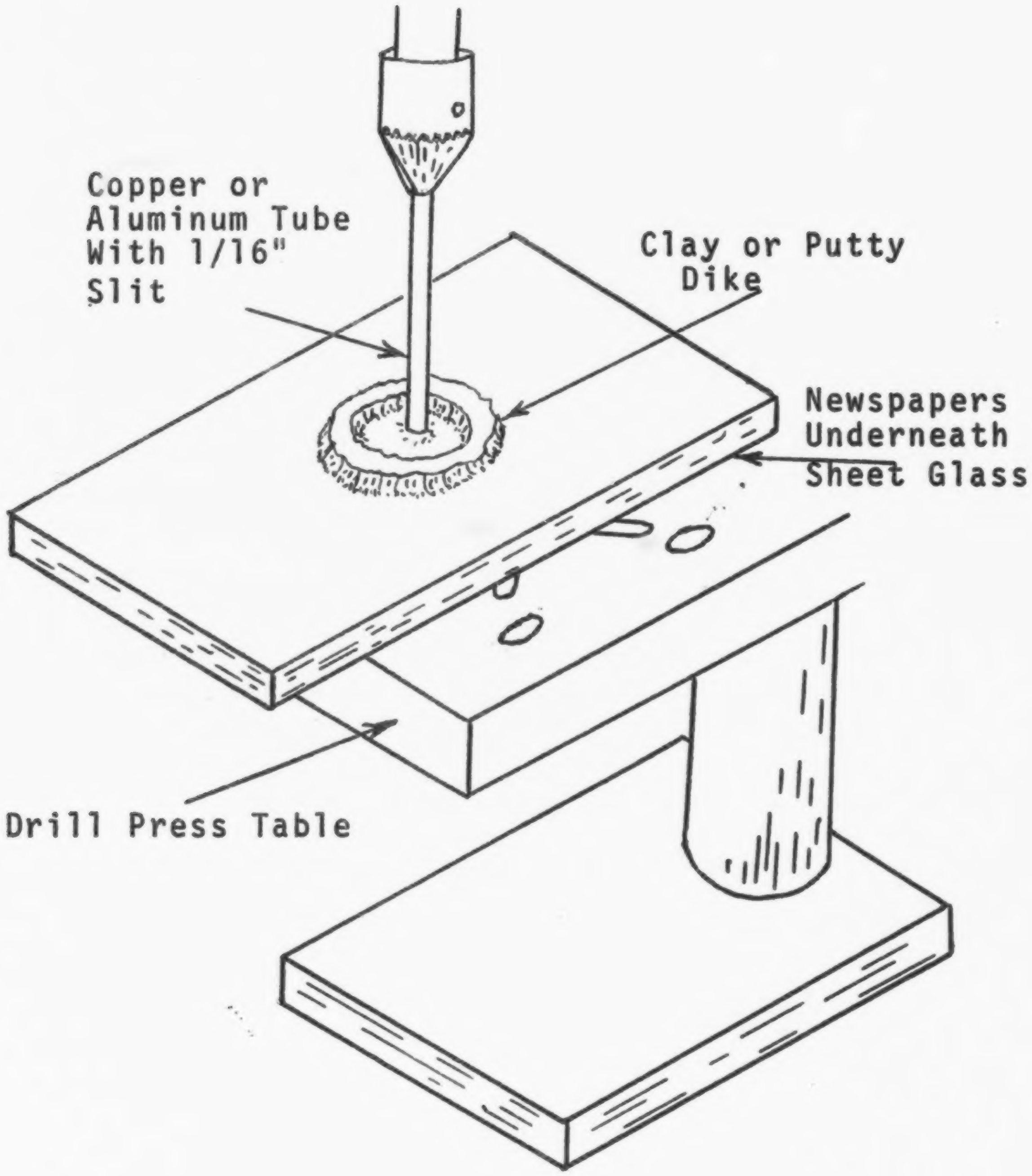
4. Build a dike of clay or putty on the glass around the hole location.

5. In the dike place about a half teaspoon of abrasive and a teaspoon of water.

6. Use only enough pressure to keep the drill cutting. Too much pressure will crack the glass.

7. Keep the abrasive fed into the drill with a small paint brush, raising the drill as you do so. (The clay or putty dam can be eliminated if valve grinding compound is used instead of grit and water.)

DRILLING A HOLE IN GLASS


Copper or Aluminum Tube With 1/16" Slit
Clay or Putty Dike
Newspapers Underneath Sheet Glass
Drill Press Table

Materials, Tools and/or Equipment Needed: (Cutting off a Bottle)

Piece of resistance wire
Auto storage battery with a rheostat, or transformer used to operate a toy train.

Procedure for Cutting Glass Bottles:

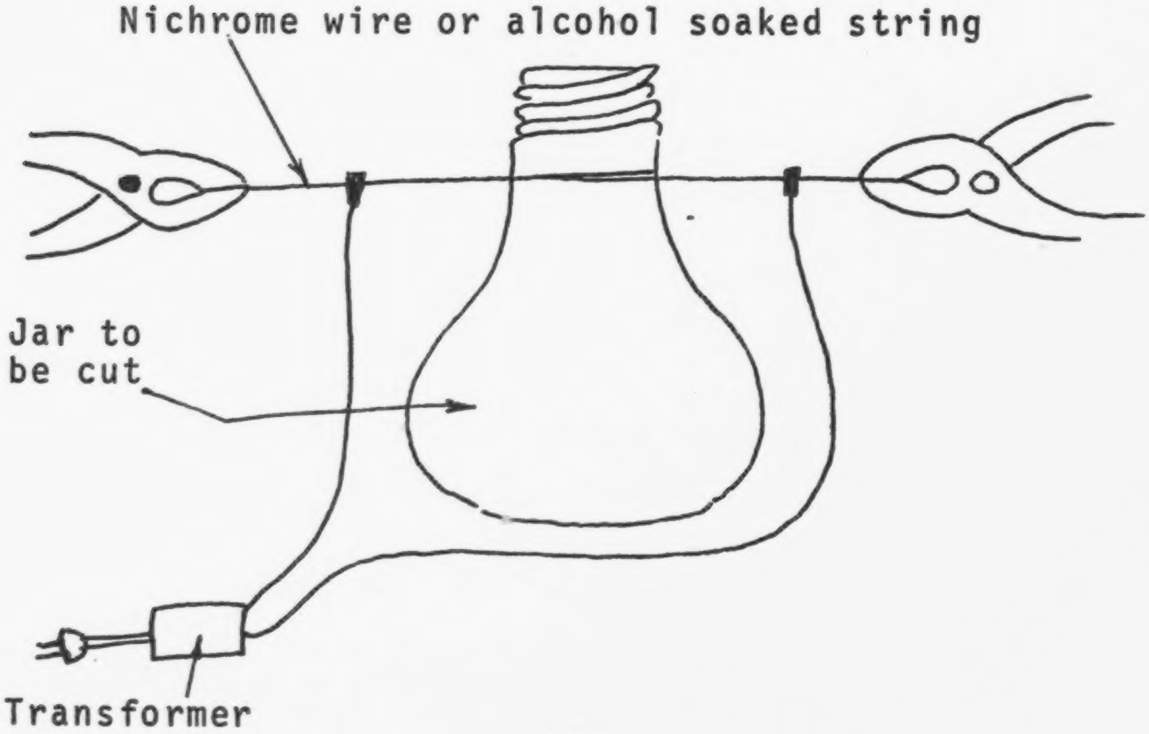
1. It is advisable but not absolutely necessary to score the bottle where the cut is to be made.

2. Clamp a piece of resistance wire tightly around the bottle where it is to be cut or on the score mark. (A piece of string soaked in alcohol may be substituted.)

3. Apply current from an auto storage battery with a rheostat or a toy transformer. The current should be only enough to heat the wire and should not be connected directly to 110/115 volts. (If the string method is used ignite the string with a match.)

4. After heating for about twenty seconds, shut off the current and immerse the bottle in a pail of cold water. This sudden chilling should crack the bottle cleanly. (If not, increase the heat for the next try.)

CUTTING A GLASS BOTTLE



Job Sheet
JS 3-9

MAKING A CONCRETE PLANTER

Use white portland cement for a durable white finish. By careful selection of special aggregates, or by choosing harmonizing colors, distinctive and unusual combinations of flower planters can be obtained.

The unit of measure for concrete is the cubic yard, which contains 27 cu. ft. Ready mixed concrete is sold by the cubic yard. Concrete produced on the job is also figured by the cubic yard. To determine the amount of concrete needed, find the volume in cubic feet of the area to be concreted and divide this figure by 27.

Cubic yards of concrete =

$$\frac{\text{width in feet} \times \text{length in feet} \times \text{thickness in feet}}{27}$$

For example, a 4-inch thick floor for a 30 x 60 ft. building would require:

$$\frac{30 \times 60 \times 1/3 \text{ (or .33)}}{27} = 22.22 \text{ cu. yd. of concrete}$$

Materials, Tools and/or Equipment Needed:

Mixing container, shovel, hoe, water, sand, coarse aggregate not exceeding 3/4 in., white portland cement, wood or metal forms for planter, small wood float, small metal trowel, plastic sheet or burlap bags.

Procedure:

1. Figure approximate amount of cubic yards of concrete you will need for the number and size planters you want to pour.
2. Use a concrete mix of 1:2:2-1/4 (1 part cement to 2 parts sand or fine aggregate to 2-1/4 parts gravel or coarse aggregate. Gravel size should not exceed 3/4 inch.)

3. Check the attached directions for the correct amount of water needed for a 1:2:2-1/4 mix.

4. Mix the ingredients by adding some of the mixing water, then gravel and cement, then sand and the balance of the mixing water. Mix all ingredients thoroughly until uniform in appearance.

5. Remove a sample of the mixed batch and examine it for stiffness and workability. If the mix is too wet, add a little more sand and coarse aggregate. If it is too stiff, the mix contains too much sand and coarse aggregate, and it will be necessary to reduce the amount of aggregate in subsequent batches. Never add more water. Adjust the consistence of the mix by varying the sand and coarse aggregate.

6. Pour the fresh concrete in the flower planter form making sure that you have an equal amount of cement surrounding the inner form.

7. The fresh concrete must be well spaded in the form. Tap the forms lightly as you work.

8. Cure the planter by leaving forms in place for 24 hours.

9. Remove forms and patch any irregularities with a mixture of cement and water mixed to creamy consistency.

10. Cure for 5 days under a plastic sheet or damp burlap bags.

CONCRETE MIXTURE PROPORTIONS

Water proportion for a 1:2:2-1/4 mixture

Gallons of water added to each sackbatch

If sand is:

Dry	Damp	Wet	Very Wet
5 gal.	4-1/2 gal.	4 gal.	3-1/2 gal.

Damp sand--sand which will fall apart after being squeezed in the palm of the hand.

Wet sand--sand which will ball in the hand when squeezed but leaves no moisture on the palm.

Very wet sand--sand that has been subjected to a recent rain or recently pumped.

Job Sheet
JS 4-1

GRAPHICALLY REPRESENTING THE TRANSPORTATION INDUSTRIES

Assignment:

Graphs make facts and figures convenient to read, simpler to compare, and easier to understand. They add interest to any book or magazine by using pictures along with words and figures. Industry makes wide use of graphs for many applications. There are four common kinds of graphs for many applications. There are four common kinds of graphs: the line and curve, bar, pictorial and circle, or pie.

Using the given statistics, you are to develop a suitable graph to illustrate important aspects of transportation industries.

You will be assigned one of the problems listed below. When finished, the graph should be properly titled and indicate clearly what it was intended to illustrate. See example attached.

1. Develop a suitable graph to illustrate the amount of cargo carried by the various transportation systems:

   Railroads - 43%
   Trucking - 23%
   Shipping - 15%
   Pipelines - 18%
   Air - 1%

2. Number of people employed in the railroad industry from 1947 - 1965, in thousands of employees:

   1947 - 1,400
   1949 - 1,250
   1951 - 1,300
   1953 - 1,250
   1955 - 1,050
   1957 - 950
   1959 - 900
   1961 - 700
   1963 - 690
   1965 - 675

3. Number of people employed in the motor freight industry from 1947 - 1965, in thousands of employees:

1947 - 550
1949 - 555
1951 - 690
1953 - 720
1955 - 775
1957 - 800
1959 - 875
1961 - 885
1963 - 925
1965 - 1000

4. Total tonnage of foreign and domestic water borne cargo from 1947 - 1965, in millions of tons:

1947 - 750
1949 - 700
1951 - 950
1953 - 950
1955 - 1,050
1957 - 1,200
1959 1,100
1961 - 1,050
1963 - 1,250
1965 - 1,300

Materials, Tools and/or Equipment Needed:

Standard drafting equipment, variety of paper--white, colored, grid, colored pencils.

Procedure:

1. Check drafting text for information on graphs.
2. Decide on what information is to be shown.
3. Choose the type of graph.
4. Decide on the scale for the graph.
5. Letter in the constant information.
6. Locate or plot the points.
7. Add the title and source of information. Make the title brief and easy to read.
8. Points to remember:

   Make sure that the line or curve, bar, etc. stands out in contrast to the background of the grid, keep the graph as simple as possible, and letter all necessary labels.

Job Sheet
JS 4-4

LAUNCHING A MODEL ROCKET

Procedure:

If your rocket has been made from a kit, make sure you follow the instructions which come with the kit which tell you how to launch the rocket and how to use the launcher.

The following procedure is a general step by step method of launching a rocket. Your instructor will advise you of any changes different from those steps listed below.

The following launching procedures are recommended for use with the ignition circuit described in JS 4-3 wiring a model rocket launch pad.

1. Disconnect battery from ignition circuit, turn all switches to "OFF" position.
2. Attach micro-clips firmly to nichrome wires at rocket.
3. Return to Firing Position, connect battery into ignition circuit.
4. Safety check the area for personnel on the ground and aircraft above. "HOLD" on launching until aircraft have passed, and ground area is "CLEAR".
5. Close first safety switch--check warning light to make sure panel is armed.
6. Begin "COUNTDOWN" 10-9-8-7-6-5-4-3-2-1-0 "FIRE". Press firing button firmly and hold until engine ignites.
7. Turn off all switches - observe "LIFTOFF" Watch for chute ejection.

Trouble Shooting Hints

If the engine does not ignite, wait at least 3 full minutes before approaching the rocket, and do the following:

Remove the entire rocket away from the launcher and set in a safe place. Back at the launcher, connect a short test piece of nichrome wire (about 2" long) between the micro-clips, close all firing switches and watch for the nichrome to glow red.

Check 'A'

If the nichrome wire glows red hot, your problem lies in the igniter installation. Remove the igniter from the engine carefully and reinstall according to the instructions above.

Check 'B'

Should the nichrome not glow at all, or glow very faintly, your problem is in the ignition circuit. Any one or more of the following conditions could result in failure of the ignition circuit.

Problem Condition & Solution

Battery connections loose or dirty -- Clean and tighten.
Battery weak or dead -- Replace or recharge.
Switches not closing properly -- Bend contacts or test switch in another circuit.
Loose wiring connections -- Check all connections - look for cold solder joints.
Micro-clips bent or dirty -- Straighten and clean with emery.

Now connect up the test piece of nichrome again, close all switches, and watch for the wire to glow red hot. If the wire heats OK, begin the launch procedure again.

If the test nichrome fails to glow, repeat Check 'A' and Check 'B' until problem is located.

Job Sheet
JS 5-2

EXTERNAL CLEANING OF A SMALL ENGINE

Introduction:

The following jobs are concerned with small engine service. All of these are typical of the jobs that may be done by a shop that specializes in small engine repair.

Read the entire job sheet and study the procedure carefully before going to work. In some cases specifications will be needed to perform the job. These "specs" may be found in the repair manual.

Remember that when disassembling to put parts in containers to avoid confusion later when assembling.

After each job is completed have it checked by the instructor, then do the assignment for the particular job.

Depending on the engine, some jobs may require a slight change in procedure. In this case check with the instructor.

Job: Clean external parts of engine.

Most small engines are air cooled. If the cooling system becomes clogged, serious damage may result from overheating. Therefore, keep the blower screen, fins on flywheel cylinder head and block free from grass and dirt.

Tools and Materials: Rags, solvent, scraper

Procedure:

1. Disconnect the spark plug wire.
2. Carefully scrape stubborn dirt from between fins, etc.
3. Dampen a rag slightly with solvent. NOTE: USE ONLY NON-FLAMMABLE SOLVENTS.

Job Sheet
JS 5-3

SERVICING AN AIR CLEANER OF A SMALL ENGINE

Job: Service Air Cleaner

Materials, Tools and/or Equipment Needed:

Non-flammable solvent, screwdriver, engine oil, cleaning pan, parts container, engine manual.

Procedure: (oil foam type)

1. Remove thumb screw.
2. Lift air cleaner from carburetor.
3. Take air cleaner element apart.
4. Wash element in non-flammable solvent.
5. Squeeze dry.
6. Reoil with 3 tablespoons of engine oil.
7. Squeeze again to spread oil through foam.
8. Assemble parts - fasten to carburetor with screw.

Procedure: (dry type)

1. Remove the filter.
2. Tap the filter lightly on a hard surface.

   NOTE: Do not immerse the element in cleaning solvent.
   Do not oil the dry type filter.

Assignment:

Write a brief report indicating the kind of engine serviced, type of air cleaner and condition and what was done to correct the situation.

4. Wipe the engine surfaces free of grease and dirt.
5. Dry the engine.
6. Replace all shields.

References:

A small engine operation and maintenance manual.

Assignment:

1. Write a brief report indicating the condition your engine was in and what you did to correct it.

CHANGING OIL IN A SMALL ENGINE

Job: Change oil (4 cycle)

Materials, Tools and/or Equipment Needed:

Drain pan, wrench, new oil, filler spout, rag, small engine manual.

Procedure:

1. Run engine until warm.
2. Remove filler plug.
3. Adjust pan to catch drain oil.
4. Remove drain plug.
5. Drain oil.
6. Replace drain plug.
7. Place engine in level position.
8. Select proper oil according to manual.
9. Pouring slowly, fill crankcase to proper level according to specifications.
10. Replace filler plug.
11. Wipe any spilled oil from engine.

Assignment:

Write a brief report indicating the kind of engine serviced, condition of the old oil, and the type of oil put in.

Job Sheet
JS 5-5

CLEANING SPARK PLUGS OF A SMALL ENGINE

Job: Check and clean spark plug.

Materials, Tools and/or Equipment Needed:

Pen knife or wire brush, spark plug wrench, solvent, feeler gauge, engine, and engine manual.

Procedure:

1. Remove spark plug wire.
2. Be sure wrench is on plug square and secure to prevent damage to plug.
3. Check plug for burned electrode or cracked porcelain.
4. Clean off carbon deposits with pen knife or wire brush and solvent.
   NOTE: Do not use abrasives to clean.
5. Check specifications to find correct gap.
6. Gap the plug.
7. Screw the plug back into the engine.
8. Connect spark plug wire.

Assignment:

Write a brief report indicating the kind of engine, type and condition of spark plug, gap of the plug, and cost of a new spark plug.

ADJUSTING A SMALL ENGINE CARBURETOR

Job: Adjust carburetor

Materials, Tools and/or Equipment Needed:

Screwdriver, engine.

Procedure:

1. For initial adjustment close needle valve, then open 1-1/2 turns.
2. Start engine and run until warm.
3. While engine is running without load, close needle valve until engine starts to lose speed.
4. Slowly open needle valve past the point of smoothest operation, until engine just begins to run unevenly. This mixture should be rich enough for operation under load.
5. Hold throttle at idle position.
6. Turn idle valve in or out until engine idles smoothly.
   NOTE: Not all engines have idle valves.

Assignment:

Write a brief report indicating the kind of engine and how engine acted before and after adjustment.

Job Sheet
JS 5-7

REMOVING CARBON DEPOSITS ON A SMALL ENGINE

Job: Remove carbon deposits

Materials, Tools and/or Equipment Needed:

Socket or box wrench (not over 6" long), screwdriver, solvent, scraper, rag, engine, engine manual.

Procedure:

1. Remove any shields, etc. to get at the head.
2. Slightly loosen each head bolt. NOTE: Note the position of each head bolt so no damage will result when assembled.
3. Continue to loosen each head bolt evenly and remove.
4. Remove head and gasket.
5. Lightly scrape any heavy carbon deposits off the head. NOTE: Be careful not to mar machined surfaces.
6. Clean head with rag and solvent.
7. Clean top of piston with rag and solvent. NOTE: Be sure dirt particles do not get lodged between piston and cylinder wall.
8. Replace gasket with a new one if necessary and install head.
9. Place head bolts in proper holes and tighten bolts gradually and evenly until snug.
10. Tighten each bolt about 1/4 turn.
11. Run engine 2-5 minutes.
12. Recheck tightness of bolts and replace all shields removed.

SMALL ENGINE STORAGE

Job: Prepare Engine for storage. (over 30 days)

Engines to be stored over 30 days should be completely drained of fuel to prevent gum deposits forming on essential carburetor parts, fuel filter, fuel lines and tank.

Materials, Tools and/or Equipment Needed:

Spark plug wrench, solvent, engine, oil, drain pan, filler spout, rag, engine manual.

Procedure:

1. Remove all fuel from fuel tank.
2. Run the engine until it stops from lack of fuel.
3. Invert engine to remove fuel from pump in tank.
4. While engine is still warm, drain oil from crankcase.
5. Refill with fresh oil.
6. Remove spark plug.
7. Pour 1 ounce SAE-30 oil into cylinder.
8. Crank slowly to distribute oil.
9. Replace spark plug.
10. Clean dirt and chaff from cylinder, cylinder head fins, and housing.

Assignment:

Set up a maintenance schedule for your lawnmower.

Job Sheet
JS 5-9

TROUBLESHOOTING A SMALL ENGINE

Job: To troubleshoot an engine

Tools and Materials:

Test equipment, engine, screwdriver, wrenches (includes torque wrench), feeler gage, spark plug wire gage.

Procedure:

The instructor will put a "bug" in each engine. It will be your job to follow the troubleshooting procedure, find the problem and correct it.

Listed below are some hints which will assist you in troubleshooting the small engine.

Visual Inspection

1. Check for fuel in the tank.
2. See that the spark plug lead is properly attached.
3. See that all fuel lines are connected properly.

4. See that all bolts and component parts are tight and in their proper place.

Mechanical

1. Pull on the rope starter or rotate the fly wheel to see if the flywheel will move as it should.

Fuel System

1. See if fuel is getting to the carburetor.
2. Check for fuel leaks.
3. Check the air cleaner for cleanliness.

Electrical System

1. Remove spark plug and check for carbon deposit.
2. Check the gap distance on the spark plug.
3. Check the amount of spark which can be obtained on the high tension lead.
4. Check timing of engine by removing the flywheel, check point gap and if needed, shift the magneto either way for proper operation of the engine.

Assignment:

Write a report stating the problem of the engine, what was done to correct it, and the tools used--keep it simple.